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THE CALEDONIAN CANAL.

[IN our last number we inserted a considerable portion of Captain Parry's Report on this work, with some extracts from the voluminous Appendix; and we now offer a few remarks of our own on one of the most singular, most magnificent, and we fear we must add most unfortunate pieces of engineering in the United Kingdom.]

THIS canal is at once the glory and the shame of Britain. It would be a glory to any country to have such a line across its most mountainous part, from sea to sea, as the "Glenn Mhor ni Albanach," along which this canal extends. It is almost a straight line of sixty-four miles in length, from the Moray Firth, at Inverness, to Loch Lunhe and Fort William on the west coast, and lying nearly in the direction of north-east and south-west. Of this sixty-four miles only twenty-two are artificial canal, the rest extending through lakes, all, with the exception of a small portion of one, sufficiently deep for any navigation, and the depth of Loch Ness, the largest one, being in some places within not much more than a cable's length of the bank, nearly 130 fathoms in depth, or deeper than any part of the sea between Britain and the Continent. These are all comparatively narrow in proportion to their length, and Loch Ness is remarkably so: its banks rise by steep slopes, and in some places walls almost perpendicular from the water's edge, excepting at a few points where lateral rivers of no great magnitude fall into it: it is near the mouths of those rivers that the only situations at all fit for anchorages occur, and even they are of very inferior description. The other parts of the lake are much too deep for a cable of ordinary length, and the weighing of an anchor of even moderate weight would be an intolerable labour. Before soundings were made, previous to the commencement of the canal, we saw a weight of two pounds let down by a line not far from the mouth of the river Feachlin, upon which the well-known fall of Foyers is situated; and the drawing up of this comparatively small weight turned the hands of those who raised it to a complete blister. The bottom of the weight, which was well greased, showed not the slightest indication of having touched the bottom of the lake, and with a weight so light, in such deep water, touching the bottom could hardly have been found out by any effect upon the cord. We believe that the composition of the bottom of this, or of any of the deeper parts of the lakes, has not been exactly ascertained; but the substratum in the vicinity, especially toward the Firth of Beauly, is stiff blue clay inclining upwards to the shore of that firth, and over this, near the shore, there is a stratum of peat, covered with loose gravel, upon which the surface mould, which is very thin where it has not been artificially improved, is deposited. This gravel, which is in general loose and in angular fragments, not in rounded nodules as though it had been rolled in water, clearly shows that there never has been a passage of the tidal water through this singular valley, at least since the gravel began to be formed by the decomposition of the surface rock. This surface rock appears to have been red sandstone and sandstone conglomerate, overlying the granite; and the line of union between the two is well worthy the study of the geologist, as showing that the granite is the newer formation, and has forced the sandstone upwards. The surface of the granite is very irregular, consisting of knolls and hollows, and the position of the strata of sandstone and conglomerate, shows that the elevations have been upheaved by the granite. The gravel which forms the alluvial deposit has evidently been produced by the action of the weather, chiefly of the frost, and similar formations are met with among the mountains, where there is neither lake nor stream of water. In some places this rough gravel is interrupted by, or intermingled with, portions of a different texture, approaching to sand, and a little to the eastward of Inverness it passes into sand altogether, which extends onward by Nairn at least as far as the great sandy shores near Forres. On the Ross-shire side of the firth, there are occasional portions of loose gravel which the streams cut into deep dells, but further up are sandstone strata, which, though partaking of the character of an indurated conglomerate, have not been disturbed by granite below, and are quarried for building stone, which, though not handsome, is very durable. In most places on the Ross-shire side, from opposite Inverness upwards, a beach of sand covers the edge of this rock, but there are places in which it is bare to the water's edge, as at Redcastle and some others. This rock shows that it has been gradually a beach at some period or other of the world's history; for though it is very hard and compact, it is intersected by the impressions of small ridges and furrows, as we find in a beach of similar materials, and the larger nodules are embedded in the furrows, while the ridges are coarse sand. The locks at the eastern ascent of the canal are formed of this stone, which is hard, but takes mortar well, and the masonry is very durable, forming a very striking contrast with the loose materials through which the channel of the canal extends. Besides the angularity of the fragments which form the greater part of the debris, there is a more convincing proof that the water has not, for a long period at least, flowed along this singular valley from sea to sea. In the middle of Loch Oich, near or at the summit level, there is an elevated ridge crossing from side to side of the valley, and connecting the rocks on the right hand of the valley with those on the left. This isthmus of rock has been found to be one of the chief obstacles to the cutting of the canal; for it requires to be excavated before there is a sufficient depth of water for any but small vessels, and the excavation of hard rock under water by means of anything analogous to a dredging machine is a most laborious task, as the weight of the water destroys much of the force of the blows. Boring and blasting the rock with gunpowder enclosed in canisters, with very long tubes for the matches, and mixed with a considerable portion of highly dried saw dust, or deal, to cause simultaneous

ignition of the greater part of the powder, and disperse the action of the blast horizontally, is the most effective way of dealing with hard rock under water, but it is under all circumstances very expensive, and was by no means so well understood when the excavation of it was first attempted as it is now.

This attempt was made nearly thirty years ago; and the contractor was furnished with at least one dredging-machine of considerable power, with striking points to break the rock, and buckets to remove the fragments. How this machine might have answered was not ascertained at the time. The machine, with its engine and punt, were brought from a considerable distance at great expense; and as the lower part of the canal was not opened, various carriages were required on different parts of the route: still, if money is obtainable in sufficient quantity, it will conceal the bad management of a piece of work from ordinary eyes; and there were none of the initiated in that remote place save those who were connected with the works, and each of them was too busy in his own department to pay attention to that of another. Thus, every one was left to do that which seemed best in his own way; and as they were near to Craggan nan Phidiach, the "Rock of the ravens," and as that bird, keen as is its vision, has no speculation in dredging machines, it heeded them not.

Well, all the apparatus was got safely in the punt and put together, but the working points had not been tried on the rock; and on a still summer's evening the barge was moored under the south shore, and the workmen landed for the night. Before the dawn had purpled the mountain tops, one of the heavy showers which are exceedingly common in the district, fell on the summit and slope to the southward. The surface there is steep, and grassy, and tender; for the soil to a considerable depth consists of gravelly substance formed of the mountain lime-stone where that overlays the granite; and it is cut in angular lines by sheep-tracks. This shower had fallen very heavily, cut the surface at the tracks, and filled the gravel with water, till a great mass had nearly the consistency of a "Scotch haggis." The weight of this was too much for the tender sod on the surface; and so the whole loose substance came hurtling down, in a slip, or "scridan;" leaving a great naked mass on the mountain side, and entering the lake by hundreds of tons; and under this the apparatus was buried at the bottom, no one knew how many feet in depth. To get up the apparatus, or even to know exactly where it might be, was out of the question, and thus the total loss of it was one of the many casualties which occurred in the progress of this most untoward work.

The execution of this canal, and the continual perplexities and failures which occurred, notwithstanding that the ground appeared on a surface view the most favourable along which a canal could be made, and that so much of the line was a canal by nature, show the indispensible necessity of a most thorough geological survey, and a careful study and perfect knowledge of all the physical circumstances, both terrestrial and atmospherical, before any great and expensive public work is undertaken. These circumstances also show, in a very clear and forcible manner, how the necessity of this correct and extensive knowledge increases in proportion as the characters of the place are peculiar, even though, to common observation, these peculiarities all appear to favour the object intended.

If we merely compare the passage "north about," and the surface of the adjacent country with the line of the glen of the lakes, we come to the conclusion that this is a passage in a great measure formed by nature herself, for a short and safe navigation. The "north about" course, through the Pentland Firth, and round Cape Rath, is the only one by open sea, between the east and west parts of the northern portion of the British dominions, and between the west coast and the Baltic and north of Europe generally. In the summer months, the Pentland Firth is not quite safe, even when the wind is moderate, for the current of tide runs very strongly in it both from west to east and from east to west, and is apt to drive vessels upon the Skerries, or rocks with which it abounds. The passage to the north of the Orkney islands is also not to be trusted even at the same seasons, for the winds shift so much, that vessels wishing to make their voyages in short time,—and in this consists much of the profit of sea traffic,—are apt to be wind-bound even there. In winter these northern passages are tedious, to the destruction of many descriptions of cargoes; and they are also terrific and destructive. Few mariners will then venture round the Orkneys, and thus they have no alternative but the turmoiling Firth and the terrific shore; and, though the Bay of Thurso is a good anchorage, considering the characters of the seas, it often becomes a trap in which a vessel is caught and detained for weeks, and sometimes for months.

No solid land intervenes between the north coast of Scotland and the Polar ice; and as the boundary of that ice, agitated as it is by the great current which sets north-eastward from the Atlantic, is not quite steady even in mid-winter, and liable to be greatly agitated before and after what is the short quiescent season of dead winter in the Polar regions, the winds are exceedingly variable, often most violent in their gusts, and the waves roll mountain high.

This tells in the aspect of the northern coast, the line of which, though formed of the most stubborn rock, is as sea-worn as can well be imagined. Here a harder stratum runs out in a far projecting promontory; there a softer one is opened far inland, in a deep but narrow bay, in which if a vessel is overtaken by a north wind it is total destruction to the ship and cargo, and certain death to the crew; for the former is rent into small fragments, and the latter drowned in the weltering waters, and their dead bodies mangled to pieces on the numerous and pointed rocks, to serve as food to the ravenous birds, and still more ravenous fishes of this direful region. In one place, a rock of more than ordinary hardness and toughness overhangs the frowning deep for many feet, and at a great height; and in other places softer strata underneath have been worked into caves, which penetrate far under the surface of the land.

Bold as is the line of coast, the spray overleaps it, and careers inland like a floating shower, which wets passengers for many miles, and coats the rocks with ice of the most slippery and dangerous character. Some of the caves, too, are perforated up to the surface of the inner ends, and the perforation is covered with vast masses of rock. The motion of these huge masses of rock shows more strikingly than any thing else that can be imagined, the power of the surges of the northern main, and the utter impossibility that even the strongest vessel could live amid them if near the coast. When the swell of the wave comes, it runs into the cave with a velocity increasing rapidly as it advances, and condensing the air before it to the pressure of many atmospheres, until it nearly

reaches the inner end under the perforation. Then the elasticity forces it upwards with immense force; and the mass of rock is volleyed many feet into the air, as from an air-gun of incalculable power, while the spray with which it is surrounded puts one in mind of something volcanic, and far more powerful than the Geysers of Iceland; and, when the wave returns to its ebb, the rock falls down upon the perforation with a crash as loud as thunder. Sometimes seals and fishes are caught in these surges and flung up into the air, whence they fall back again into the aperture, or alight sprawling on the rock, and are often killed, and almost actually dashed to pieces there. In other parts of the coast, where the depth of the water is less, and shattered fragments surround the base of the precipice, these are lifted up by the swelling surge, and dashed thundering against the steep, as though they were shot discharged from artillery of the largest bore and the most powerful charge. Then, as the swing of the waves retreats backwards, they fall down, not unfrequently increased in their number; and this is one display of the force with which the sea can assail the land, even when its coast is composed of the boldest and most stubborn rock.

Such are not unusual displays upon the coast between the Pentland Firth and Cape Rath, when the wind is strong from the north, and the sea is in all the horrors of its Borean majesty. A near view of them from seaward cannot however be obtained; because no human being, be he on board of what he may, can be a close witness, and live to tell the tale. Even on land the examination of this extreme working of nature is not seen without very considerable annoyance, and occasionally with peril; but enough is known to establish more than we have now stated, and more indeed than language can express. Now, in the long winter nights, when moonless and the sky overcast, night sailing, or steaming, or any sort of traffic of the waters along this shore, is dangerous in the highest degree, for the atmosphere is variable, and no one knows what storms a single night may bring forth. Therefore, even when there happens to be no actual danger, a winter passage along this way is exceedingly tedious and costly, both in the wear and tear of ships, and the wages and fatigue of sailors. In the dead months of winter, there is not much occasion for passages here; but in the earlier parts of the season, the westerly bound ships return from the Baltic, and the time of their return is very nearly that of the greatest turbulence of the sea. In that turbulence they derive no benefit from the Polar ice which is formed or forming, because that lies too far off the land for having any influence in checking the vibration, and by that means diminishing the action of the waves in the intervening sea. Upon no occasion is any portion of the ice within a shorter distance of the Scotch coast than about a thousand miles; and of course it has not the slightest influence here; but if it were near the land, leaving only a narrow passage open, that passage might have its water as still as a lake, while that to seaward of the ice were running mountains, as is often found in the early and late parts of the season by vessels which pursue the whale fishery in the Polar seas. Thus those who attempt the navigation by the "north about" passage in winter, have all the Polar changes, and even more, without any of the Polar protection.

That there should be a natural valley, or ravine, extending in almost a straight line from the deep indenture of the Moray Firth on the east coast, to the deep indenture of Loch Eil and Loch Linnhe on the west coast, across this very mountainous part of the country, and cleft down until the surface of the summit level is only 94 feet above the mean tideway in the first of these, and 90 feet above the mean tideway in the last, is rather a singular circumstance, and one of a very interesting nature for a canal, by which all the delays, terrors, and dangers of the "north about" passage may be avoided. It is still more singular that, excepting in Loch Oich, as already mentioned, and at Colachie, three miles south-west of Fort Augustus, there is no rock crossing the ravine excepting at a very great depth. The dike, or band of rock across Loch Oich has been already mentioned. That at Colachie lies somewhat deeper, and is of no great breadth, being sufficient only for the foundation of a lock, which, from the compactness of this stratum, does not require an inverted arch in the bottom, as is necessary in all the other rocks upon the line of the canal. The rock here is greywacke, a mountain of conglomerate rock consisting of pieces of quartz, flint, slate, feldspar, and clay-slate, cemented with the basis of the last. This is a rock which has been in part, at least, formed in water; but from the quantity of clay it contains, it has been shrivelled and rent in drying by some means, volcanic or other, and the openings are filled with veins of quartz, or metallic ores. The latter have, in times long gone by, been worked for iron, for the scoria and charcoal produced by small blast mines of the very old fashion are met with on the slopes, and regarded by the ignorant as volcanic, as is the case with the vestiges of beacon fires upon Craig Phaidrick and other heights. With the exception of these two small portions, the whole bottom of the valley is gravel, generally of an exceedingly loose and porous nature, and as badly adapted for canal making as can well be imagined.

Nor is the porous nature of the gravel the only difficulty with which the excavators of this canal had to contend; for the whole of the works approximate to the banks of rivers, which are apt to flood the canal in some places, and to drain it in others. In the north-eastern reach of the canal, from Loch Ness, or rather its continuation of Loch Dochfour to the sea, there is nothing to be apprehended from flooding; because, although much matter descends from the mountains, both during the rains and the melting of the snow, the great extent of lake acts as a regulating dam, and the water never rises more than seven or eight feet, though in the comparatively small rivers to the north-east of the Ness, the floods may at the same time rise twenty or thirty feet, and sweep the valleys with overwhelming devastation. Drainage is the annoyance to be guarded against in this reach, and it is both troublesome and expensive, but it was so well described by "H." in our preceding number, from personal observation, that we need not further allude to it here.

The Oich, though considerably smaller than the Ness, is yet a river of no inconsiderable magnitude. It drains a large extent of country to the northward of the glen of the canal; and its most remote sources are at no great distance from the west coast. The district is also very rainy, and the snow falls heavily in winter and melts rapidly in spring. Hence the Oich is much more subject to floods than the Ness; but still it is less so than some much smaller rivers in that part of the country. This is owing to Loch Garry, which acts partially as a regulating dam, although it is too small for being a complete one. These partial floods, however, render protection to the canal against the floods of the river highly necessary; and we believe that upon this rock, both to the eastward and the westward of Loch Oich, there is little to be apprehended from leakage or drainage of the canal. Near Colachie, the charac-

ter of the rock changes, and partially also that of the soil in the bottom, because it contains a portion of decomposed grey-wacke, which is of a clayey nature. The hills are green, and though this is near the summit level, it has a more fertile aspect than the soil adjoining Loch Ness. This last is an exceedingly loose gravel bed in the vicinity of Fort Augustus; and at a considerable distance from the lake, the water in the gravel stands as high as in the lake itself, and perhaps a little higher, from the capillary attraction of the gravel. A cluster of three locks are formed in this gravel; and in excavating up to them, and partially in them, the glacis of Fort Augustus had to be cut through. This cutting was in ordinary matter down to the level of the water in the lake, or nearly so; but below this it was much more serious, and the workmen could not get on at all by the ordinary process of shovel, and barrow, and wagon, for, as fast as it was attempted to take the gravel out, water came in and smothered the operation. Therefore, after several trials and failures, dredging machines worked by steam-engines were resorted to. By them the gravel was taken up in punt boats with draw bottoms; and these were towed to some distance into Loch Ness, the bottoms drawn, and the gravel discharged in deep water there. This plan proceeded rapidly and well; and the contractor, whose suggestion it was, performed the excavation at not above half the cost which was intended to be offered for doing it in the ordinary way; and yet made a handsome profit by his contract. This circumstance not only shows that many contingencies occur in work, especially earth work, which the most skilful and experienced engineer can neither appreciate nor understand; and hence it is necessary that the contractors should be men of intelligence and resource, so that they may not only be able to overcome such difficulties without ruining themselves, but that they may come in and put matters to rights when the engineer himself is at a loss. The western reach of the canal from Loch Lochy to Corpach on Loch Eil, requires aqueducts, the excavation of the rock for the basin Corpach, and sundry expensive operations not required at the other extremity; but the operations there, though of a different kind, are still very expensive; and, considering its comparatively short length and small rise, the geological character of the ground rendered the execution of this canal very difficult and expensive, and it is yet by no means in a state calculated to answer the purposes originally intended. Reports have been made as to what requires to be done in order to effect this, and estimates have been made of the expence; but, without questioning the talents or experience of the reporters in ordinary cases, we doubt whether they have sufficiently informed themselves of the geological and other physical circumstances, for being able to report rightly on this very peculiar and puzzling case. We know not who should be appointed to such an office as this; but certainly it ought not to be a mere naval officer like Captain Parry, nor do we know that there is now living in the country a single engineer competent for doing this: but still it ought to be done; for about a million sterling is rather too much to be thrown away; and this line of passage is far too valuable for being left as the ruin of something unfinished, or as a failure for want of skill in those concerns, of which it at present has the appearance. Mr. President Walker is now the government engineer for all matters, and also as a leading engineer for other parties, but though we are ready to admit his ability, we do not think that he is either competent to understand this place, or possessed of leisure and some other requisites for learning it. The time has gone by at which it could have been best and most cheaply completed; because Messrs. Jessop and Telford, and the resident engineers, together with the principal contractors who had been all the time occupied on the line, are gone, without leaving any successors; and since railways began to engross the chief attention of engineers and of the public, we have no school in which a proper canal engineer can be bred. Why the work was not completed, in all its length, appointments, and approaches, while they were engaged on it, is a matter which we profess ourselves unable to explain. It was begun with great eagerness, and carried on for a time with great velocity, regardless of expense; but the parties who had the control appear to have sickened at the work at the very time it was required that they should redouble their energies. Such things have occasionally occurred in other great works, both public and private, and the memorials which remain of them, being begun, but not finished, are, not unaptly, termed "follies."

Considering its northern latitude, and the high, rainy, snowy, and bleak mountains among which it is situated, this glen is remarkable for the mildness of its temperature, especially that of the waters and margins of the larger lakes varies but little all the year round; and the other lochs, especially Loch Lochy, have something of the same character, but not in such perfection. It is almost unnecessary to mention the cause of the total absence of ice from Loch Ness, because it is now known to every tyro in the study of nature; but as there are still some who attribute it to a mixture of sulphuric acid or some other ingredients, which would cool the water instead of keeping it warm, we may briefly mention the cause as one of the physical circumstances of the locality. The greatest density of water is at a temperature lower than the average of Loch Ness; and when the cold season sets in and cools the thinnest pellicle imaginable of the surface down to this temperature, or near it, the cooled surface sinks with extreme slowness, and a new surface presents itself to the cooling action of the atmosphere, and when cooled it sinks, and presents a third surface, and so on. In the course of winter there may be several of these descents, and yet the surface may never descend to that degree at which it would become quiescent, and ultimately disposed to freeze; and hence the absence of ice.

The water which flows directly into Loch Ness by the rivers Urquhart, Glen Morriston, and a few others, is too inconsiderable in quantity for affecting the temperature of the loch; and even the Oich has comparatively little influence upon it. But the water which flows into that lake is colder in winter than Loch Ness, and, therefore, though the deep parts are never frozen, ice does form on the banks of Loch Oich, as well as on the canal in juxta-position with them. Even this, however, is trifling; and so is the ice which forms in the quiescent basin eastward Clacknahrry; and if the canal were in moderate use during the winter season, the ice would never form the slightest obstruction; for, even at the summit level, where it has the greatest tendency to form, a steam tug of very limited power would cut through the ice of several days without appearing to meet with any opposition.

The lower temperature and consequently greater weight of the water discharged by the Oich than that of the water of Loch Ness prevent it, notwithstanding its superior impetus and velocity, from flowing directly to the place of discharge of Bona Ferry, as it would do if the water of the Oich were warmer than that of the loch, or equally warm. The water of Loch Oich sinks gradually below the other, though most likely not to the bottom, till it impinges on

an inclined plane which slopes upward to some dislodgement of the gravel, and carries it onward to Loch Dochfour, where it is deposited. What may be the case now we are unable to say; but before the bed of the Ness was altered under Torvain, and Loch Dochfour was dammed up by the canal operations, there was little, if any, of this gravel which now leaves Loch Dochfour; for, from hence to the sea, the Ness is comparatively clear even when swollen, and it runs in a wide but not very deep channel, with a considerable current. This motion of the current of water in the loch, does not bring floating substances directly down; and thus, though there were no dams, weirs, or other obstacles, the timber floated down from Glengarry, and other woody districts upon the streams, would not be carried directly to Inverness by the current; as matters stand, it is thrown about, and has to be collected from the bogs and sinuosities of the Loch, into which it is carried when the water is high, and started when that subsides. At the western or Corpach end of the coast, nothing of this kind takes place. The only river of consequence which discharges itself into Loch Lochy is that which comes in from the north-west, through Loch Arkeg; and this passes off at the south-west end, and rolls onward to Loch Eil at Corpach. At a short distance below its exit from the loch, the Lochy, a river of considerable though not great magnitude, with a violent current, and after flowing along a very deep channel which it has formed for itself, comes in from the left-hand or south-east side of the loch. This is a very turbulent stream; and where it and the loch meet there is a rather powerful setting of the joint waters against the right or opposite bank. It is on this side that the canal passes; and its bank has to be strongly protected against this joint current, otherwise it would be cut through in a short time, and a considerable extent of the works destroyed. Such are the leading physical circumstances of the great glen of the Highlands; and it will be perceived that many of them are adverse to the making a canal, and probably have not been examined by any engineer with that attention which they require; and, therefore, there is still much for the young engineer to study in this very peculiar locality. This is the reason why we entered somewhat largely into these desultory accounts, because they have not been so much as mentioned in the report of Captain Parry, or any of the other recent ones; and what was said of them formerly was imperfect and not very accurate.

In the marine approaches to both entrances of the canal, there is naturally something peculiar: we say naturally, for one has yet done, we believe, nothing for either of them; and it is passing strange that the canal should have been opened even for vessels of the lightest burden, without a buoy, or a beacon, or a light to guide the mariner in those narrow seas. We cannot believe that any such thing was intended as that of leaving the work in as ruined a state as possible; but we have already said that those who had the management and held the purse, sickened of the work; and it was natural for Mr. Telford, appointed as he was by them, to do the same, and hence arose, in all probability, the miserable state in which it was left about twenty years ago, and in which it still remains, to the shame of the country, and the serious injury of its navigation. The peculiarities to which we allude are a sort of receiving basins formed by nature; the one at the east end extending from the ferry of Fort George, which is formed chiefly by the projection of the long point of land which juts outward from Fortrose on the opposite side of the estuary, to the entrance of the canal at Clacknaharry; and the western one extending from the canal entrance at Corpach to the waving and somewhat turbulent ferry at the Coran of Ardgower, which separates, or rather forms, the nominal and partial division between the south end of Loch Eil and Loch Linnhe. These receiving basins, as we may call them, are in the line of the canal: but each has an appendage which stretches inward in a different direction, and belongs to a separate valley, being divided from the glen of the lake by mountains. The eastern appendage is the Firth of Beauly, rather a calm expanse of water, which extends westward between sloping and not very elevated banks, which are in some places, especially on the southern side, highly beautiful, and very fertile. The appendage of the westward basin also extends westward to the mouth of Loch Eil, and consists of waters, the extremity of which approaches the western shore between Moydart and the long peninsula of Ardnamurchan. It would not be difficult to form by this route a passage from the entrance of the canal direct to the Atlantic; and this passage, if properly formed, would always be preferable to the southern one, which contains numerous islets and rocks, and the sea is often in considerable agitation, and coasting vessels are lost, especially near the Coran. A steam boat struck hereabouts some years ago; and Macdonnel of Glengarry, attempting to escape by jumping on the rocks, fell headlong, and was dashed to pieces. The basin of sea between Fort George and Clacknaharry or Inverness is wider, and there are sand and gravel banks with shallow water in some places, but in others there are good ship channels; and as the points which overtop each other at Fort George break the swell of the Moray Firth, the water inside is never very turbulent or dangerous; and we have seen the whole surface smoking like a furnace with drift and spray, while there was nothing that could be called a wave of any magnitude. At Kessoch, a little below Clacknaharry, and between that and the mouth of the river Ness, there is a good anchorage ground, where vessels ride in safety without the slightest danger of coming ashore, dragging their anchors, or parting or even dragging their cables; and as the water is not very deep, anchors are easily weighed. This ground is very convenient for vessels while waiting a convenient time for entering the canal; and we are not aware that there is any such convenience on the south-western extremity. Still the portion of the Firth, which may be called the Firth of Inverness, between Fort George and Kessoch, is a little troublesome, on account of the banks and shallows; and would require beacons, at least one light, to guide mariners to the canal entrance, for though there is not much danger of serious injury from grounding on the banks or shallows, such accidents might occasion tedious delays.

Having thus given an outline of all the physical characters of the canal and its approaches, that is, the natural line along which it passes, with the sea approaches, we shall now say something of the works which have been done, and of the instructions and propositions for doing those works.

The first notion which was entertained respecting this canal, or indeed respecting any improvement of a general nature, or encouraged by government, or those under government authority, was entertained in 1773; and the party chosen to make the preliminary inquiry was the illustrious Watt, who, though professedly a machinist rather than a civil engineer, was a man of great ability, discernment, and knowledge of every subject which came under his observation. He was employed by the commissioner for the management of some forfeited estates to make a survey—the first we believe that ever was made, of the central highlands, and gave in a report for certain improvements of the same. He recom-

mended the construction of the Cremon canal across the peninsula of Cantyre, for avoiding the tedious and dangerous navigation round the Mull, or southern point of that peninsula, and opening a direct communication between Loch Fine and Oban on the Sound of Mull. From its position and short length, this canal had evident reference to Tobermory, and the other fishing stations which were then established or establishing, but which have turned out to be total failures, apparently in consequence of the ignorance of the parties by whom they were projected. Another and more important recommendation by Mr. Watt was the Caledonian canal, which we are now noticing; but as it did not fall in with any scheme of the government or the commissioners, the object of whose primal attention then was the points along the line of the canal, and the projected fisheries, no notice was taken of it for nearly thirteen years. In these days, though most of the forfeited estates had been restored, and the feudal power of the Highland chiefs abolished, no attention whatever was paid by those in power, either to increasing the value of the Highlands, or adding to the scanty comfort of their inhabitants.

The efficiency of the Highland troops in the American war and the war of the French revolution, tended, however, to bring the neglected mountains and glens a little more under the notice of those at head quarters; and, though the grand object was the obtaining of soldiers, the country in which they were reared began to have a little attention bestowed upon it.

Accordingly, in 1802, chiefly with a view to the increase and improvement of sheep-farming, Mr. Telford was employed by the Lords of the Admiraltyto survey the central highlands, with a view to the formation of lines of road, and the construction of a canal of such dimensions as that it would float vessels carrying twenty-eight guns. The report being obtained, a parliamentary committee was appointed, and engineers and gentlemen of the navy were appointed carefully to examine it. Mr. Jessop may be regarded as having been at that time the leading engineer, as he was the senior one, and the principal points were determined by him, assisted by Mr. Duncombe, before his meeting with Mr. Telford at Edinburgh, in the autumn of the same year.

The result of those examinations and surveys, and the reports founded on them, was that in 1803 an act was passed, granting his Majesty £20,000 toward defraying the expenses of this canal. Mr. Telford was appointed engineer under this act; but Mr. Jessop was to be called in wherever it might be deemed necessary. The two together proceeded to deliberate carefully on the subject, grounding their deliberations mainly upon the examinations made by Mr. Jessop; but there was one grand point which was not attended to as he recommended; and this appears to have been the primary cause of all the subsequent difficulties, disappointments, and temporary failures in the construction of the canal, the results of which still continue to be very conspicuous, and will continue so, or probably require the cost to be doubled, before they can be wholly got the better of.

The opinion of Mr. Jessop, founded on an actual survey, was, that the whole glen from sea to sea had been originally filled with water much deeper than the tideway in either, and that, in the intervals of the lakes, it had gradually been filled up with water-washed gravel to the present level; and that, consequently, it was the very worst soil for the formation of a canal that could possibly be imagined. Substantially, as applied to the greater part of the line this opinion was correct. But the whole could not well have been at any period an open water-course from sea to sea, for, had it been so, the four feet of greater elevation at the west end would have occasioned a continual current eastward, the result of which would have been a scouring, not a filling-up of the passage. Thus, though Mr. Jessop was quite correct in so far as the unfitness of the soil for a canal, yet his theory of the original state and filling up of the glen was inaccurate; and this, perhaps, caused less attention to be paid to his objection to the soil than ought to have been; thus the opinion of Mr. Jessop, even that part of it which was perfectly sound, and highly valuable, appears to have been overlooked or rejected. This is a subject of far greater importance to engineers, and especially to the public, than the designing or the execution of any single work, whatever that work may be; for, upon careful and close examination, we find that it mingles with and vitiates, more or less, every public work that can be named in this country. But the public overlook this, and hence it is continued with impunity, and a British public work differs from one of any other country, by there always being more or less of a job in it for the benefit of some private party or other.

That which the public inquires most after, and loves most to read and to know of the works of men, is analogous to what they are most inquisitive about respecting men themselves. They seek for the romantic or novel, be it false or be it true; but they care not one straw for its philosophy. Be it ever so silly, ever so false, or ever so contrary to nature, they eagerly seek for and read it with the most voracious appetite; but present to them the analysis of the matter —the philosophy of human action, from which alone a true judgment of character or a right rule of action can be obtained, and they turn from it as though it were an adder in the path. Even so in the case of the works of men, especially those that are of the engineering class. The cry is for what is "Practical," meaning, the mere gossip of what is done; but they will not be informed as to the only part of the matter that is worth seeking after,—the propriety of what is done, and the motives and the means, in order to ascertain whether they are the purest and the best. These are shunned and avoided as dry disquisition and uncalled-for philosophy; and yet, from the want of public attention to them, every public work costs a fourth, or probably a half more than it ought to cost, and is done in the very worst manner after all.

We shall point out no individual instance of a very modern public work, because that would be an invidious charging of one individual, or individuals, with what is the vice of a system, and as such common to all, but we call upon any man who can do so with knowledge and without prejudice, to look at the whole, judge for himself, and say whether, if the public possessed the proper kind of knowledge, such a state of things would be tolerated. Take the railways, for instance, which have been the "lions" of our public works for several years, and the most expensive and noisy that ever were undertaken: is any one among them what it ought to be, either in the plan or the execution? He were a bold man who, amid all the deformities and frailties of the lines, would dare to answer this question in the affirmative; and he would stand contradicted by the accidents which occur both to human beings, and from the mere imperfection of the works themselves, when nobody is near them. Withdraw all traffic at the end of spring, and leave every one of them to the drought of a summer, the rain of an autumn, the frost of a pretty severe winter, and the thaws of another spring; and by the time that the year were completed, it would be useless. Now, what sort of public works are they of which perish-

ability, without being used, is the conspicuous quality, and which, like the sword of Hudibras,

> "Eat into themselves, for lack
> Of somebody to hick and hack?"

Can they be skilfully engineered, or properly executed? Or, rather, would they not be a shame to the parties, if shame could be predicated of the parties, and not of the system? *Sed sic omnia*, however, and so we notice them *obiter*, and pass on. This need not be restricted to engineering matters, for it applies to every thing public in our country, and to many things private.

We have not taken our illustrations of the Caledonian canal, with even the most remote intention of throwing any shade upon the fair fame of Mr. Telford. We knew him intimately, and though upon some points connected with engineering, he had a crotchet or two, especially in his later years, no man could stand more proudly through life than he did for the greatness and readiness of his talents, or the open and straight-forward manliness and purity of his character. We admit too, and that with readiness and pleasure, that, at the time when he was appointed chief engineer to the commissioners for the Caledonian canal, Mr. Telford had got no small renown for canal works. But at that time, and all along, his abilities shone far more conspicuously in building than in earthwork; and this is the chief reason why we think he should have paid more deference to the opinion of Mr. Jessop, respecting the nature of the ground. Mr. Jessop was the senior engineer, and that alone ought to have given weight to his opinion, more especially as he had carefully surveyed the ground, and the result has shown that his opinion was in strict accordance with the facts of the case.

Instead of this, however, it appears that any thing different from earthwork in ordinary soils was overlooked or disregarded; and that reliance for the retention in the canal of the requisite quantity of water was placed in the unlimitable supply, obtainable at the heads of all the reaches. It should have been recollected, that though the Atlantic had been the means of supply, a canal could not have been extended from it in a trough of wicker-work. The bed of this canal was not wicker-work, certainly, but there were some parts not much less permeable by water. The gravel in some places was mixed with no smaller material save the wind, which blew freely through it under the thin soil, and one could push one's arm into it up to the shoulder, without displacing a single fragment. Then, where there was finer matters interspersed, that in most instances consisted of quicksand, which, instead of having any tendency to bind the gravel, was washed out by the first application of water. The pressure from the increased depth of water intended to be in the canal, was another trial on the banks: Watt had proposed a depth of ten feet, which would have given a pressure on the banks equal to those of an equilateral prism ten feet on the side; but the pressure of water on the banks of canals, increases as the squares of the depth; and, therefore, when the depth was doubled, the pressure was increased fourfold; so that, if the pressure on a foot in length of the canal 10 feet deep, be 2706¼ lb., that on the same length, and 20 feet deep, will be 10,825 lb. Whether these circumstances were calculated as a guide in working the banks of this canal, we do not know; but at all events they were not acted on.

Then, again, we must enter our caveat against the supposition that we are laying the blame on Mr. Telford; for we are of opinion that it ought to be be laid on the commissioners, just as the chief blame for having blundered and botched the railways ought to be laid on the committees. In such cases, the engineer is merely a servant, and a servant of ignorant masters, who wish a certain end to be gained, but know nothing about the means to be used in order to obtain that end in a proper and durable manner. Their object is, to get what they wish for done as speedily as can be, and at the smallest possible expense; and thus the execution of the work becomes a strange medley of overpaid jobbing for what any man could do, and still more ruinous parsimony in those matters where talent and discernment of the highest order ought to be employed, and adequately remunerated.

There is one description of work on the Caledonian canal, which appears to have been as well executed as works of the kind can be, and which forms a remarkable contrast with the earthwork. This is the masonry, especially that of the locks, which was executed by Messrs. Simpson and Cargill, the former of whom had had much and successful experience in works of a similar kind. It was well for their credit, and the character of this part of the undertaking, that the original notion of side banks of earth for the locks was abandoned, and masonry used instead; for, had the original plan been persisted in, not one of the locks would have held water, and the work would have been no better than a wicker trough from the one end to the other. But though the masonry is well done, the doing of it is very expensive, both from the preparation of the sites or levels of the locks, and for the stonework, especially at the western termination, where the materials had to be brought from a great distance. The sea-locks, in particular, were very costly; that at the east end having to be extended a long way between artificial mounds of rubbish, and those to the west requiring the excavation of rock not fit for building purposes.

The substratum here consists, not of gravel, but of a loose mixture of silt and clay of a bluish colour, and about 54 feet in thickness, and this reposes on a whitish clay, the thickness of which was not ascertained. From the great quantity of water in the silty substance, the mound pressed about 11 feet down into it, and it was found necessary to compress, by similar means, the place between the mounds where the sea-lock was to be founded. After this compression, the substance was found to be so compact, that no piling or coffer-dam was required, and thus the expense of the mounds saved another, and in all probability a greater one, while the foundation was more uniform. Thus, though the discovery was accidental, the engineers, both superintending and resident, deserve credit for having turned it to so good account.

A little inward of the sea lock is the first canal lock, a piece of most substantial masonry, which opens into the receiving basin, which is of large dimensions, and was formed partly by embankment and partly by excavation; and much of the stuff employed in the formation of it being indurated clay, it is water-tight, and the canal is nearly so up to the Muirton locks, which are at no very great distance. The fact of water standing in this part of the excavation, probably misled both engineer and contractor, with regard to those other parts which are so very leaky. The two locks which have been mentioned give, taken together, a rise of 15 feet 2 inches above the mean tideway in the Beauly firth, and with this, the canal starts for the proximate locks at Muirton, of which there are four in a continuous series, the side walls being continuous through the whole. These four locks give an additional rise of 28 feet, which, with that of the two lower ones, gives a height of 43 feet 2 inches to the reach of the canal, extending from there to Loch Ness, or rather to Loch Dochfour, which it was necessary to take into

the same navigation with Loch Ness. Along this reach, the construction consisted of common earth-work cutting and embanking, both of which were, however, very expensive, especially the former where the bed of the Ness was altered at Torvain, and the latter, where materials for puddling had to be brought from a considerable distance, and were not very good or very well placed after all. In many places, the leakage water escapes through the lower parts of the embankments in clear streams; and it is highly probable that, where this is not the case, it percolates into the loose gravel of the bottom, and thus finds its way to the river Ness unobserved. This is rendered very likely, both by the nature of the soil, and by the quantity of water which enters the reach at the upper end, as this, making every allowance for evaporation, is far greater than what is apparently discharged along the surface of the ground.

One of the most difficult operations on this end of the canal, was the deepening of Loch Dochfour, and the forming of a navigation between it and Loch Ness, through the narrow passage at Barn Ferry, where naturally the current ran rapidly, and, as has been mentioned, brought down with it large quantities of gravel. Dredging was resorted to to a considerable extent, and the machine lifted 90,000 tons in the course of a year, which was removed by punts, and deposited in places where it was presumed not to return again into the channel which had been excavated for vessels. In the course of this dredging, some difficulties occurred which are not usually met with in such an operation: large stones, which had no doubt rolled down from the high cliffs on the north-west, and the roots of large trees, probably some of them at least occupying the situations in which they had grown, were mixed with the gravel, and had to be lifted and removed. The first of these operations could not be performed by the buckets which are usually attached to the endless chain of a dredging machine, and, therefore, when such substances had to be taken up, the buckets required to be removed, and strong bent prongs substituted in their place. This greatly increased the expense of the dredging, and, after all, it was found that no application of that process could, in consequence of the fall from Bona to the bottom of Loch Dochfour, and the rapidity of the current at and near Bona, unite the two lochs into one navigation. Accordingly, the deficiency of this mode of operation had to be made up by extending a weir across the river Ness, where it reaches from Loch Dochfour, and raising it until the whole lake and connecting strait had the requisite depth of water in dry weather, when the Ness was lowered. This, again, was an expensive operation, but it was presumed that the damming up of the water till it had a tranquil surface, would in a great measure prevent the influx and accumulation of gravel in Loch Dochfour. There has been no report upon this part of the case, nor, as the light craft which have only hitherto navigated the passage do not require nearly the proposed twenty feet of water, has there been any very minute examination made to ascertain whether or not gravel is still coming in at Bona, and gradually lessening the depth of Loch Lochfour. Of this, however, we have some doubts. We have already stated that the current passes under the smooth water of Loch Ness rather than along the surface; and we have our suspicions that, though the smooth water is extended along the whole length of Dochfour, the gravel will in part at least be carried into that loch as before. But still, though this should be the case, the deposit will always be of such a nature as that it can be taken up by the common dredging buckets; and the worst will be the keeping of a dredging machine upon the loch, which, however, would be costly in a part of the country where coal is so expensive.

We have not had an opportunity of examining the weir, or of knowing how it is formed, or of what materials; but from what we have seen of other rivers, whose quantity of water and velocity of current are not greater than those of the Ness, we are inclined to regard them as perishable things, even when formed of the most durable materials, say hewn stone set on end and of considerable length. The damage always takes place at the tail of the outer slope, even before there is the slightest symptom of giving way in the weir itself. The water descending the slope of the weir has much the same effect as when it descends a rapid in a river, namely, the formation of a deep pool at the tail or lower part of the descent, only that its progress is more rapid and ruinous in the weir than in the river. In a river the rapid is almost invariably formed along a ledge of rocks, immediately below which there is a softer stratum; but the rocks themselves usually belong to the earth-fast class, that is, they penetrate so deeply into the ground, that the passing water has no tendency to undermine and overturn the lower part; and thus the only wear to which they are subject is the attrition of the water, and gravel, and sand, that it carries along, which, in the case of tender rocks, has more effect than a casual observer would be apt to suppose. It is very different in the case of even the best constructed and most substantial weir; for, admitting that it is formed of squared stone, that stone cannot penetrate to any great depth into the ground, and there is always water below it, which mixes with the smaller particles, and thus is in so far sludgy or mortarous. Thus an increased flow of water agitates the matter of the weir, and if it descends with force, and especially if there is any sort of fall at the tail of it, the stones give way, and are rolled to a greater or less distance, according to their own weight and the force of the stream. The best mode of preventing this, or at least delaying its occurrence and lessening its effect, is to give the section of the descending slope of the weir the form of a parabola, to extend that parabola until the last part of it is level or parallel to the surface of the ordinary flow of the river, and take especial care that there is no inclination, and especially no fall where it meets the natural bed: as we have said, we have no information as to whether the weir across the Ness, at the lower part of Loch Dochfour, is constructed in this manner, and we throw out these hints not so much with reference to it as to works generally, as the true principles of their construction seem but imperfectly understood. Whatever may be the form and character of this weir, it cannot be worse than that of the reach below it; and as the situation is rather favourable, we suspect it must be better. For passing this weir a lock is necessary, and it requires to be a kind of regulating one, having various depths of water according to the state of the loch, and requiring a total depth equal to the sum of the depth of the canal, and the height to which the waters rise. We have stated, and indeed it must be obvious without any statement, that the great extent of Loch Ness, acting as a regulating dam, prevents the heavy floods that occur in those rivers of the same district which have no lakes in their course. But still the difference of level between the dry and rainy season is considerable, amounting to six or eight feet; and adequate provision has been made for this in the regulating lock. That lock brings the canal up to about fifty-three feet higher than the tide-way in Beauly Firth; and thus only about forty-one feet of additional rise has to be provided for in order to gain the summit level. The distance from the tide-way

to the lock of Loch Dochfour is about six miles; and after this there is an uninterrupted navigation of about twenty-four miles, the chief part over very deep water and in a narrow dell between high mountains, as has been said. The current opinion that the wind along this canal almost constantly sets from the south-west, is not exactly true; for though the south-west is the general wind all over Britain, the country of mountains and dells across which the canal lies, is, like all such countries, remarkable for variable winds; and if a local and temporary wind crosses the valley it may be broken into gusts and eddies; but upon the whole it will overcome any irregular winds from the north-east or south-west, especially as the surface is much too low for its being acted upon by the last of these. Gusts and whirlwinds passing across Loch Ness are the most troublesome agitations of the atmosphere over that lake; and the prevailing ones come from the north-west down Glen Urquhart and Glen Moriston. The late Mr. Milligan, who was minister of Dores, on the south-east side of Loch Ness, and near the bottom of it, but still several miles within the gorge of the mountains, kept a register of the weather for years, which shows that the wind is as variable in Loch Ness, at least in that portion of it, as in any part of that country. Variable winds, and a channel too narrow for square-rigged vessels to tack in, and the absence of anything like a decent anchorage, are the grand obstacles to ships attempting to sail along these lochs. It is also impossible to tow them along by horses, as the bays would render that mode of passage, long and slow under any circumstances, still longer and slower; and there are many places where the precipices descend from great heights immediately into the deep water, so that no towing path could possibly be formed. Therefore there is but one alternative, namely, the use of a steam tug of the requisite power; and as there were no such craft when the canal was planned, the fact of getting a vessel along the loch the best way it could, by sailing amid difficulties and dangers, must be set down as one of the engineering blunders of the canal as originally planned,—a blunder which the engineers may have thought of, but not seeing any very practicable remedy, they did what men usually do in such cases, that is, they said nothing about the matter.

The second reach of the canal, or that extending from Fort Augustus to Loch Lochy, is of no great length. It rises by four locks at Fort Augustus, and one at Callachie, about three miles to the westward. These locks have been already mentioned; and the loose gravel in which the Fort Augustus ones are constructed, and the belt of greywacke which serves for the bottom of that at Callachie, has also been noticed. From this to the regulating lock, at the lower end of Loch Lochy, the canal, with the exception of the regulating lock, about half a mile from Loch Oich, is a dead level, including Loch Oich and Lock Lochy; and these locks give a rise of 41 feet, which, with the 53 to Loch Ness, completes the eastern ascent. The water-shed, or highest surface of the valley, is between them; but so little does it rise above their level that even deep cutting was not necessary. The section of Loch Oich taken along its length consists of three basins, divided by cross ridges of rock, one of which, as has already been said, rises considerably nearer to the surface than is necessary for the twenty feet estimated depth of the canal, and therefore requires excavation under water. The other rises to a less height, and does not require any such excavation. These two ridges of rock, rising from the bottom of this small lake, divide it into a sort of three caldrons, of which the eastern one is by much the largest, and the others diminish to the west. This form of the bottom of the loch has, however, no influence upon the navigation, farther than the lowering of the rocks, which has been mentioned; and the shallow parts are apt to be covered with thin ice towards the close of severe winters; but this ice is never so strong as that a steam tug of very moderate power could not at any time break it up without sensibly impeding its own progress. The same tug which is absolutely necessary for comfortable navigation along Loch Dochfour and Loch Ness would answer this purpose by passing the locks, which, for those at Fort Augustus, would require towing, but the rest of the reach would not; and the passage of this tug occasionally, when it was not required for shipping, would keep the reach open in all states of the weather. This would occupy some time, and incur some expense; but as a proper establishment of lock-men ought to be constantly on the ground, the expense would be reduced to that of the fuel and wear and tear of the tug, which would not be great; and the men being on a regular establishment would be no additional expense. The obtaining and keeping up of the tug, and the establishment of the lock-men, at this, and indeed at all the locks, presupposes a very considerable traffic if the canal is to pay its own expenses. That this traffic would be very considerable if the canal were what it ought to be, is established by the testimony of 102 gentlemen of the different towns, selected for their knowledge of shipping. This however, ought not to be considered as in any degree a private speculation for the remuneration or the profit of any one party, but as a public work, constructed and kept up mainly for the benefit of those who use it; that it will ever pay the additional expense, or even interest upon that expense, is entirely out of the question; and as the expense has been already nearly one million, and the completing of the canal and organization of a proper establishment will probably cost half a million, or possibly, a million more, the returns in any dues which the trade could bear would be so mere a bagatelle, that it would be even more absurd than spending the pound and saving the farthing. The expedition and safety afforded to shipping, especially in tempestuous seasons of the year, when the passage north-about is liable to such tedious delays, and such complicated and fearful dangers, is the grand advantage of the canal; and if it answers this as fully in the construction and establishment as it does in the situation, the consideration of Government making a profit may be thrown overboard as useless lumber. It is beneath the character of the British Government to speculate for profits in anything that they undertake, and the truth of this is established by the fact, that where they make such an attempt, they, as Paddy said of his luck in the lottery, "Gain a loss." Many instances of this might be given; but they will naturally occur to any one who is acquainted with the annals of the country, and can view them without prejudice, either for or against any project or party. Among foreigners we are proverbially the money-losing nation, which, in all probability, arises from our having more money to lose than our neighbours. In war we gain glory both by sea and by land; but when we come to estimate the expense, it is always apparent that we should save our pockets if we purchased the glory ready made, though even at a very high charge.

This consideration ought to be kept in view when we look at the object and the use of the Caledonian Canal; and as that is a public work, the Government ought, as in other cases, to exult in the glory, without any unpleasant feeling as to the expense, which has gone, and will go to "the tomb of the Capulets." In order to

avoid cutting at the summit level, which would have been expensive, the waters of Loch Lochy were raised twelve feet by means of a mound; and a new channel has been opened for that river, so that one regulating dock suffices for the whole height. From this south-westward through Lochaber the canal has no descent until a series of locks is arrived at at no very great distance from the sea: these are eight in number, all continuous, and occupy a range of five hundred yards in length, with about sixty feet of a rise in the whole series. Their great extent, which, like the others, is forty feet in width and twenty feet deep, the length over which they extend, and the continuity of so much masonry, render the general effect very imposing, and in volume at least it has no equal in any canal work with which we are acquainted. From this series of locks the canal extends between one and two miles across the moss of Corpach, where there is a double lock immediately connected with the receiving basin, the entrance to which is between two artificial mounds, extending about 250 yards into Lochiel; and here the canal works terminate, though part of the plan is to open a passage directly westward to the Atlantic, and another part to shut up the Ferry of Coran so far as to render all Lochiel a sort of basin, unconnected by a open passage with the sea, and thus undisturbed by its agitations, which, in certain states of the weather, are very violent.

Such is a brief and desultory outline of the Caledonian Canal, in its locality, in the physical circumstances connected with that locality, in the works that have been done, and in the facilities and difficulties, the successes and the failures, of the doing of them. We have endeavoured to compress all the points upon which we have touched into the smallest compass possible; but they are so numerous that we have greatly exceeded the limits we originally intended. There is one ground upon which this is, in part at least, excusable. We have not here treated systematically and simply of the Caledonian Canal as a single work, but rather making use of it as a general vehicle for conveying to the reader some notices of the successes and failures of public works, with the causes of the same; and we may remark, *en passant*, that if any one, fully competent to the task and free from prejudice, would enter thoroughly into this matter, he would produce one of the most useful books that ever was written. Notwithstanding the multitude of private jobs, and the parliamentary encouragement which is given to them, often without much inquiry or knowledge on the part of the givers, a good deal has been paid out of the public purse for works intended to be of general accommodation, and much more requires still to be done. Another thing is imperious: our Government, when off the lands under the immediate management of the crown, which form a very insignificant part of the whole, have no power even to construct a mill-pond, or open or close a foot path, unless this power is granted them by parliament; therefore, it behoves parliament to gird itself in all its multitude and in all its might, and do for the people here what the executive governments do for the people in other and differently governed countries. This, however, is not done; and it does not appear that any one consideration or subject, be it what it may, has sufficient interest for moving the whole mass of parliament, and especially for moving it all in the same way.

The great body get rid of the study and the trouble by transferring them over to commissions; and, in too many cases, those commissions ought to be committed either for the grossest ignorance or the most culpuble bungling and neglect. The Caledonian Canal is an instance of this; and we cannot in the mean time name a single public work which does not fall within the same category. It is not, however, in every case that we meet with the evils or incapacities of a commission so glaringly portrayed as they are in the Caledonian Canal. Most of the members are now defunct *civiliter* if not in the course of nature; and, therefore, the taboo of *nil nisi bonum* is thrown over them as a shield against all kinds of censure. But still, when we regard the locality, the first plan, and the initial alacrity in the matter of the Caledonian Canal, and contrast them with the strange abortion, or rather the sooterkin thrice deformed, which the present state of the works presents, we cannot help holding up our hands in utter astonishment, but without any disposition to parody the distich which the Highland laird made on the military roads when they were first opened through parts of the country previously impassable and impenetrable,—

> "If you'd but seen these roads before they were made,
> You would hold up your hands and bless General Wade."

SMOKE-BURNING APPARATUS.

In situations where smoke is produced in large quantity, as, for example, in manufacturing towns where steam-engines are numerous, smoke is, to say the best of it, a very great nuisance. It is doubtful, however, whether it is so deleterious to health as is sometimes supposed. The most pernicious product is carbonic acid, which arises from perfect combustion; and the more free the fuel is from other ingredients than carbon, the production of this deleterious gas is the more abundant. It is the greatest of all from charcoal of timber, next from timber itself, thirdly from coke of coal, and fourthly from coal as it comes undecomposed from the mine. The black smoke, which is composed chiefly of vapour of water, and consists of unburnt carbon, is most abundant in that from native coal; and it is mixed with other ingredients, some of them injurious to health and some not. For instance, it contains an admixture of pyroligneous acid, and frequently a little sulphuric acid; and in the quantity in which they exist, these are not pernicious to health, but rather the reverse. With the exception of the carbonic acid, the substances now mentioned form but a small part of the product of combustion. When the combustion is incomplete the other substances are gases,—carbonic acid, carburetted hydrogen, bi-carburetted hydrogen—also called olefiant gas, and hydrogen; of these the hydrogen and bi-carburetted hydrogen are the most abundant; and the remains of them after fire or refination give that peculiar noxious smell to the gas used for light, and the smell is still more noxious in the gas if not purified by passing it through lime water.

In proportion as the combustion is more nearly complete, and the carbon more abundant, the black smoke, or unburnt carbon, with its accompanying ingredients, are less numerous; and when the combustion is perfect, transparent carbonic acid is produced, without any coloured matter, which either soils other substances or is injurious to vegetation; but which, when it exceeds a certain proportion, is highly injurious to human life when inhaled in breathing. Charcoal of timber, and next to it timber itself, are most productive of carbonic acid, and people are often suffocated in situations where this

acid accumulates in large quantity. There are situations where this takes place naturally, that is, it is given out at the surface of the ground without any appearance of surface combustion, though it is probable that there is combustion at some depth, and the resulting gas ecapes through fissures. The Grotto del Cani in Italy, and the Valley of Death in Java, are instances of this; and the latter is the most pernicious situation, both to animal life and to vegetation, which occurs anywhere on the surface of the earth. It contains not a single particle of vegetation; and such animals as have the misfortune to enter it are instantly killed, so that it abounds with bones, consisting of the skeletons of men and other animals. These examples show how terribly fatal is an accumulation of pure carbonic acid gas; and though it is never so pure in the case of surface fires, there are many instances of suffocation by it. These generally take place during the night, and when the places of repose are lower than those from which the gas escapes into the open air, and the most destructive are those resulting from the combustion of timber or its charcoal. When this carbonic acid gets freely into the atmosphere, that fluid never holds quite so much as one thousandth part of its own volume, and, therefore, it is never injurious to health except when accumulated as has been said. Its superior gravity makes the surplus carbonic acid fall down to the earth, where it has important services to perform, the explanation of which is foreign to our present purpose; and the portion of it which does not immediately enter into these new combinations, runs down to the lowest places of the surface; and if there is nothing to combine with it there, it forms a poisonous atmosphere, as in the Grotto del Cani and the Valley of Death.

The black smoke is the greatest nuisance, on account of the offensiveness of its smell, and also from its soiling the clothes, and all substances which it reaches; but though it is thus a nuisance, and is unhealthy in some respects, as well as offensive, it is not poisonous, but rather the reverse. This is shown by the London fog, which, though the greater part is vapour of water, sometimes contains a considerable portion of black smoke; and we were informed by the late Mr. Earle, the eminent surgeon, who was a man of keen observation, as well as great talent, that, when the London fog sets in, the fever wards are very soon deserted of their patients, which shows that whatever may be the effect of the smoke contained in this fog in the case of other diseases, it is medicinal in that of fever.

The primary constituents of smoke are carbon, hydrogen, and oxygen, though the oxygen is not a combustible, but the agent of combustion, and its uniting with them is the cause of all the phenomena of fire and smoke. Of the ingredients, carbonic acid, being the ultimate result of burning, is incombustible, and extinguishes instead of feeding fire. Vapour of water is also a product of combustion—a compound of oxygen and hydrogen, and as such it is not combustible: the two parts merely combine, and rise in the air as liquid water in proportion to the temperature. Of the others, uncombined carbon burns with little or no flame, just as is the case with pure charcoal and coke, which consists of carbon after the more combustible matters are burned out of it. These matters all burn readily and rapidly, though they differ in degree; and they are the elements of the flame of common fires, gas lights, and almost all artificial lights.

From these circumstances we may infer both what is the cause of smoke, and what is the means of burning so as to make it disappear. The smoke arises from deficiency of oxygen, and hence the disappearance of it is produced by adding the requisite supply of that gas; and according as the fuel contains more of the more highly combustible ingredients, the lower is the heat necessary to kindle the fire or otherwise begin the combustion.

The want of a sufficient supply of oxygen is owing partly to the nature of the fuel, and partly to the stove or apparatus in which it is burnt. Deficiency from fuel is caused by that of the more inflamable ingredients, because in that case the fire does not produce heat enough for maintaining perfect combustion, and thus the carbon, which is least apt to combine with oxygen, passes off in an uncombined state. When the fault is in the fuel it cannot be cured, because the more combustible part of it cannot be increased in proportion to the less combustible; and, therefore, the only improvement is an additional supply of oxygen. Of this, in its pure state, there are no artificial means of getting a greater supply than any ordinary application of fire would bear; and, therefore, a greater current of air, produced by bellows, by a blowing-machine, or by the better kind of smoke-consuming engines, is all that can be had.

When the fault is in the stove or other apparatus, the simple correction is, that it shall admit more air, bring that air as much as possible upwards through the fire, and give it greater velocity. But, though this may make the fire burn better, it does not, as commonly used, burn the smoke, but in the majority of cases it increases it. We have examples of this in the fires of steam engines, and in other fires, when the chimneys are low. On land, the chimney can be raised to such a height as to diminish the quantity of smoke, though it does so only very partially. The great production of black smoke takes place when the fire is fed; and fires of steam engines, especially those employed in steam navigation, produce more smoke than any others. The last do not admit of high chimneys; and in the usual way of heating them a large quantity of fuel is generally put on, and the consequence is, that a large volume of very dark smoke is produced; and in the case of steam ships it sometimes extends for a mile or more.

The radical cure for smoke, and indeed the foundation of all the smoke-burning apparatus, whatever may be its apparent nature, is the passing of a current of oxygen over the fire, in addition to that which enters in the usual way. If this could be so regulated as that the oxygen varied with the tendency to produce smoke, and could always burn the whole of it, the cure would be complete. But this is not the case with any apparatus which has hitherto been constructed; and, from the number and variety of them, a perfect one can scarcely be expected. Those that have been contrived, and even those which are in use, which are but a fraction of the total number, appear in many, and indeed in most instances, disguises of the principle by various apparatus, machines, and engines, which do not approach nearly to perfection. But such is not the case with machines generally.

The old-fashioned under-shot corn-mill, for instance, does not admit of any improvement in the proportion between the initial and resulting power, which is the grand property of a machine of the kind. There is also only one steam engine, although there are small differences in trifling parts, but a substantial improvement would apply to every engine; and the discoveries have respect only to small parts and particular applications. With smoke-burning machines the case is very different; for, good or bad, the contriver makes a new machine, no small part of the value of which, such as it is, depends upon its novelty. Still, however, where it is abun-

dant, as is the case in our larger towns, which are crowded with manufactories and steam engines, smoke is an intolerable nuisance, and the inhabitants are constantly seeking means whereby to get more completely rid of it, and this gives encouragement to a host of contrivers, the greater part of whom do not appear to have very much knowledge of the subject. Leeds abounds more in steam engines and in smoke than perhaps any other town in the kingdom, and, therefore, the people of Leeds are always alive to the operation of smoke burning. A pamphlet now lies before us, compiled by Mr. West, of Highfield House, near Leeds, and giving the circumstantial details of an anti-smoke meeting, and committee resulting from the same. The meeting was very numerous and respectable, and the committee consists of very competent men; but we have our doubts as to the soundness of the knowledge which they have collected. Their informants are, almost to a man, inventors of smoke-burning apparatus; and thus each was naturally more disposed to puff his own contrivance than to treat of the general principle as it ought to be treated; but still we are glad that the subject is to call forth permanent attention, and we hope that some good will result from it. The pamphlet is much too long to quote, and cannot be easily abridged, and thus we give only the simple notices of the engines now under patent, leaving out the garnish and the puffing.

INVENTIONS PROTECTED BY LETTERS PATENT.

John Chanter and Co.'s Patents.

These patents are granted for various improvements in furnaces and boilers. The most improved plan for furnace and steam-boilers consists in gradually drying and preparing the coal for liberating the gases for combustion, which gases are then burnt with the smoke in the hottest part of the furnace—the only place where, in the opinion of the inventor, they can be consumed with the greatest economy of fuel; the carburetted hydrogen being there supplied with a sufficient quantity of oxygen, by means of a tube under the first fire grate in the centre of the furnace. Should any smoke escape from this first process, it is re-heated under the reverberating arch, where the carbonic oxide gas is generated, and then being brought in contact with a fresh supply of atmospheric air, heated by iron plates in a chamber in the sides of the furnace above the grate, it is conveyed to and inflamed at the bridge of the furnace, where final and complete combustion of the smoke is effected. It must be observed, that in the above arrangement there are two separate fire-grates, one to liberate the gases, and the other to effect their combustion.

The patents for improvements in boilers comprise an auxiliary or supernumerary boiler, which is attached to the main boiler, and connected with it by pipes, to cause circulation and draw off the sediment; also a deflective boiler, adapted to steam-boats; and a chamber boiler, by which power is obtained in two-thirds of the size of ordinary waggon boilers. All are stated by the patentees to be so constructed as to consume smoke and save fuel.

John Hopkins's Patent.

It consists of a fire-bridge, of a curved form, intended to arrest the heat and flame, together with the smoke to be burned, in their progress, and throw them back from the end of the furnace, so as to cause them to pass again over the surface of the burning fuel.

In marine engines and others, where desirable, the bridge may be constructed hollow, of metal, and connected with the main boiler.

I have received no testimonials, or other particulars, relative to this method. So far as benefit is derived from its use, it may be applied to other boilers than those of steam-engines, and to furnaces where the action of flame beyond the bridge is not required.

Samuel Hall's Patent.

A number of cast-iron pipes are placed in the flue leading from the boiler to the chimney, through which a quantity of atmospheric air passes, and is thereby heated to about three hundred degrees; it then issues in the form of a wide sheet, at the front of the furnace, to enter into mixture with the smoke, or inflammable gases, as they are evolved from the fuel. In this part of the fire these inflame at a lower temperature than after they become mixed, in their progress towards the bridge, with products of combustion no longer inflammable. Besides the advantage which the inventor considers heated air, thus applied, to possess over cold, it is clear that being warmed in that part of the flue where all which passes off would be wasted, the pipes bring back a portion of heat, which thus aids in a direct manner the further generation of steam.

Samuel Hall claims the right, under his first patent, to the use of hot air for the purpose of consuming smoke, in whatever manner the air may be heated, provided such hot air is introduced at the front of the furnace.

The second patent includes a mechanical stoker, for the purpose of distributing the coal, and preventing clinkers, methods of applying heated air to locomotive engines, and several other important particulars connected with the combustion of smoke and economy of fuel.

Ivison's, or Bell's Patent.

The principle of Ivison's patent is the discharge into the furnace, abov the fuel, of a very small quantity of steam taken from the boiler, along with the admission of a due proportion of atmospheric air. The proportion of steam requisite is found to be from a twenty-fifth to a twentieth of the whole quantity produced.

The atmospheric air may be applied either heated or cold; the former is greatly preferable, and the increase of the draught arising from the use of the steam in the furnace, admits, according to the statement of the patentees, of the heat for the air being derived from the smoke flues, or the bridges, or other situations where otherwise it would be thrown away. The patentees are of opinion that, without the use of steam, heated air cannot be applied to boilers with advantage.

The air tubes are laid in the flues, so that one end communicates with the open air; the other is placed just behind the fan, or distributor of the apparatus, and when the furnace doors are shut, the draught of the chimney, increased by the jet of steam, causes the atmospheric air to flow through these tubes into the fire. The patentees frequently use an arrangement, by which the heated air is discharged into the ashpit, which is then entirely closed, and all cold air excluded from the furnace.

Joseph Price's Patent Boiler.

Joseph Price, Durham Glass-works, Gateshead, has obtained a patent for an improved form of boiler, which he states to possess many advantages, and he has no doubt it will consume its smoke; but it does not appear that this has been hitherto the principal object of the invention. I have received no testimonials as to its action in this respect, nor particulars of its construction. The patent is dated 26th July, 1838. Application for further particulars may be made to him, as above.

Richard Rodda's Patent

Consists in drawing the smoke through the fire, and through passages composed of fire-brick, strongly heated. The smoke is previously mixed with a due proportion of atmospheric air, admitted through a box or valve over or near the fire-door, which valve is opened or shut as the gases may require.

Cheetham's, or Bayley's Patent.

This plan consumes the smoke by means of a fan, placed in such a position as to catch the most inflammable portion, which it propels along with a certain portion of atmospheric air into a close ashpit; thus causing it to be forced through the fire.

Paul Chappe's Patent.

It consists in the injection of a thin sheet, or numerous small jets of boiling water, over the fire in front of the bridge, by which it is intended to effect the combustion of the smoke. The inventor also advises that a similar jet be projected either at the end of the flues, or in the chimney. For steam-engine furnaces, this water may be supplied by means of a pipe from the boiler; for other furnaces, it must be specially provided. I have received no reply to my application for testimonials, agents, places to view, &c. Those who expect benefit from this method, may apply it with any other plan; or, by attaching a small boiler to supply the hot water, may use it with any kind of furnace.

James Drew's Patent.

The fire-bars are formed in two sets, the front half being laid on fixed bearers, in the usual manner, while those at the back are on a frame, which is capable of being raised and lowered, by rack-work or otherwise. The first, or outer set of bars, is intended to receive the fresh fuel; which, when it becomes charred and red-hot, is to be pushed backwards upon the

second, or moveable set of fire-bars, and raised as near as may be wished to the bottom of the boiler. The smoke from the fresh fuel is intended to be burnt in its passage over the heated embers on the back-grate.

No testimonials, or similar information, accompanied this communication; and it does not appear to be at present in use. Those who incline to make trial of it, will be aware that it may be used with any kind of coal, and under any boiler having a nearly flat bottom.

Thomas Hall's Patent.

Mr. Hall's patent is founded on the division of the furnace lengthwise, by brick-work, into two or more parts, which are fed with fresh coal alternately, and not together. The superfluous carbon (smoke) from the side last fed, is burnt on meeting with the current from the clear side of the fire.

C. W. Williams' Patent Argand Furnace.

This furnace has been named after the Argand gas-burner, from the identity of principle which governs both, namely, the bringing the air and the combustible gases together by jets or thin films, thus producing an enlarged surface for mutual contact and diffusion.

The action of this furnace is stated by the inventor to be based on introducing the air by a separate channel, without compelling it to pass through the fire-bars and ignited fuel on them, and of causing the atoms of the inflammable gases from the coal to be intimately mixed with their equivalent proportions of atmospheric air, before the former are cooled down below the temperature required for their ignition.

The principle on which this furnace acts is also attended with this desirable result, that it spreads the flame and inflammable gases during their combustion more uniformly under the boiler and along the flues, whereas, by the ordinary method, the heat is chiefly confined to the furnace. Again, the air being introduced to the gas behind the bridge, the flame necessarily extends farther, and is less intense under any particular part of the boiler, than if its admission had been confined to the ash-pit and bars alone.

The mode of applying the principle, either by perforated tubes, or plates with numerous narrow orifices, will necessarily vary according to the nature of the boilers or furnaces, or the intensity of heat required. Where the intensity is great, and the draught considerable, plates are preferable to tubes, to avoid the burning of the latter. The principle, however, is applicable to all descriptions of furnaces, and to the use of anthracite as well as bituminous coal, seeing that a large volume of inflammable gas (carbonic oxide) is generated in furnaces supplied with anthracite, and which also requires its due proportion of air behind the bridge, as well as the gas (carburetted hydrogen) commonly called coal gas.

George Bodmer's Patent.

I have not found the specification, or any description of this patent; and particulars, promised by the inventor, have not yet arrived.

Richard Prosser's Patent.

Instead of the ordinary bridge, the inventor places the bridge at a distance from the ends of the fire-bars, and close against the bottom of the boiler; the gases, thus prevented from passing along the boiler in the ordinary way, are carried through flues or openings in the bridge to a chamber beyond the bridge, and thence to the chimney. The space between the end of the fire-bars and the bridge is fire-brick, forming an inclined plane, upon which the red-hot fuel is intended to be pushed, so as to keep these bricks heated, for the purpose of effecting the combustion of the gases and smoke.

Andre Kurtz's Patent.

The consumption of smoke is proposed to be effected by a peculiar position of the grate-bars in the furnace, there being three sets, those at each end inclining towards the middle, so that the bars of the middle set, which are horizontal, are lower than the two ends of the furnace, and the great body of heated fuel is in the middle. Also, by placing these fire-bars upon hollow bearers open to the ash-pit, and in connection with passages which communicate with apertures in the furnace; the air passages are closed from the external atmosphere by doors which are only opened occasionally, to clean the flues, the fire-doors being shut, and the ash-pit also closed, except a slight opening for the requisite supply of air, the air enters the hollow bearers, and being thus heated, rushes into the furnace, to effect the combustion of the smoke. Additional arrangements are made, if needful, for a further extension of the hot air passages, and the construction is varied to suit boilers of different shapes.

Foard's, or Godson's Patent.

The furnace is fed from below, the frame or bed carrying the fire-bars being lowered for that purpose, while the red hot fuel already in the furnace is supported by a sliding plate or false bottom. This plate is then withdrawn, and the fuel raised from time to time, as it burns away. The smoke from the new coal is mixed with the air which enters through the bars, and these pass together through the heated fuel, for the purpose of effecting the combustion of the smoke.

Baron Von Rathen's Patent Undulating Fire-grate.

The principal part of the invention is a fire-grate, of which the fire-bars, being double or hollow, rest upon bearers, with steps, and thus ascending or descending, form two sides of a triangle, which include spaces or hollows, in which the coals are placed. In this way the object of the inventor is attained, viz., to enlarge the area of the contact of the air with the coals.

The other and subordinate parts are, a coal-feeder placed over the dead plate, and having a moveable door, with a lever projecting outside, by which the fireman can shake the coals forward, without opening the doors of the fire-box; air bars on the side of the fire-grate, by which a small portion of fresh air out of the closed furnace can enter the fire-box; and two ash-grates, with small round bars, one over the other, and both under the fire-grate, to receive cinders and glowing ashes falling from the head fire-grate, and to prevent the cold air entering through a regulating air-door placed beneath the lowest ash-grate in the closed furnace, from rushing up in an undivided mass to the fire-grate. The air is forced to pass through or behind the ash-grate bars, in small sheets, and becomes by this means warmed before it reaches the head fire-grate.

J. C. Douglas's Patent.

The gases from the fire pass over a bridge, from whence they descend under another bridge, into the space beneath another set of fire-bars; thence they ascend, and it is intended that the smoke passing through the fuel in combustion, shall be deprived of its carbon, whilst the permanently elastic gases proceed to the flue or chimney.

J. Howard & Co.'s Patent.

These are the gentlemen whose agent created so much merriment at the Leeds meeting by coming from a distance to *decline* giving any information. Supposing he might misunderstand the intention of the inquiries made by the chairman, and being desirous to give every patentee an opportunity of stating his recommendations to the public, I addressed, several weeks since, a courteous letter to their office in London. As they have not thought fit to reply, and I have discovered no patent granted *under this name*, I need state no more than that a patent is said to exist.

THE FALLING IN OF WALLER'S ASH TUNNEL ON THE SOUTH-WESTERN RAILWAY.

During the past month, the newspapers have related full particulars of a serious loss of life, occasioned by the falling in of a part of this tunnel, on Saturday the 2nd of April. We have nothing to add in the way of description to what has already been so fully detailed, but as the facts which have come out on the investigation are highly important in an engineering point of view, affording, as they do, a valuable practical lesson in the construction of similar works, we make no apology for introducing some comments of our own by a relation of these facts, and by a brief extract from the evidence of Mr. Locke, in order to place the professional circumstances and bearing of the case before our readers in a condensed form.

It seems that the Waller's Ash Tunnel is a short one, of about 300 yards in length, situate near the village of Micheldever, about five miles north of Winchester. It is driven through the upper part of the chalk formation. In describing the nature and cause of the falling in, we cannot do better than quote from the very clear and minute explanation given by Mr. Locke, the engineer in chief, at the inquest on the bodies of the four men who were killed.

"At the part where the accident occurred," says Mr. Locke, "there is a peculiarity in the construction of this tunnel. A large conical-shaped piece of chalk fell from the roof of the tunnel after the excavation and before the completion of the brick-work, leaving a dome-shaped cavity extending nearly 20 feet above the crown of the arch. . . . . The brickwork, in consequence of that slip, was strengthened in that particular place, and from the time the brickwork was built, till last Monday, no change was observed. In every other part of that tunnel, and of all others on the line, the brickwork fits tightly into the solid chalk. . . . . After the tunnel was completed, a question arose as to the best means of filling up the vacancy above the arch, and it was ultimately determined to sink a shaft there, which was done to the depth of about 20 feet, the total depth of the arch being 45 or 50 feet. The arch was perfect: there was no perforation in the brickwork. The entire face of the work, as far as the cavity extended, was filled up with chalk to the depth of about 10 feet, which was as much as was considered proper to be done without loading the arch unequally from the irregularities in the shaft. By the subsidence or settlement of the material, we calculated that the cavity would be gradually filled up without injury to the brickwork." Such is Mr. Locke's statement, to which we have simply to add, that indications of danger being observed a few days before the 2nd of April, a gang of men was set to work in the shaft, to remove some loose stuff which had fallen down from the top of the cavity described by Mr. Locke, on the filling or backing, which had been placed on the crown of the arch.

Whilst the men were at work for this purpose, the roof suddenly fell in to the extent of about 20 feet square, the superincumbent earth of course falling with it, and burying in the ruins four unfortunate men, who were killed, and also several others, who were more or less severely injured.

Mr. Locke thus describes the cause and the extent of the falling in:—"On my arrival," he says, "I found that the arch had fallen in immediately under the shaft, to the extent of about 20 feet square, and directly under the apex of the cone to which I before alluded. I cannot account for the sudden giving way of the arch after having remained so long unaltered, except on the supposition that the brick-work having been fractured by the previous fall of chalk, the working of the miners above might have shaken it." Mr. Locke stated, in answer to a question by the jury, that the thickness of the arch in the tunnel varies from 1 foot to 18 inches, but where the accident took place, the crown of the arch is 2 feet 4 inches in thickness.

It will now be seen, that this accident furnishes very clear evidence of the danger and impropriety of leaving the space between the brickwork and the solid earth in a tunnel unoccupied by well rammed or pounded earth. Every common bricklayer—every rustic stonemason, knows the necessity of backing up an arch with a sufficient thickness of pounded earth to prevent unequal settlement, and even in so trifling an affair as a small culvert, one seldom witnesses the neglect of this very proper precaution. This being the case, we might naturally expect to find that, in such important works as the tunnels on railways, involving by their possible instability such terrific consequences to human life, the business of backing up the arch in as solid a manner as possible, so as to assimilate the filling in with the solid stuff above, and thus equalize the pressure of the earth, had met with the most scrupulous attention, and been executed in the most complete and effectual manner. Would that we could in justice express an opinion to this effect—would that we could honestly assert that the public prejudices and apprehensions with reference to the danger of tunnels are unfounded! It is much to be regretted that the inefficient execution of some of the great lines (we do not say the South Western is amongst the number) has a very great and obvious tendency to throw discredit upon all railways and all engineers, and there is no class of works upon railways, whose execution has effected more mischief in this way than that of tunnels. It is a glaring and monstrous dereliction of professional duty—it is one which no urgency of directors to hasten the completion of their works can justify—for an engineer to push the execution of a work at the sacrifice of any single precaution which is necessary to the stability of that work. We shall recur to this again, but in the mean time, it should be observed that the Waller's Ash is a very peculiar case. It was not here as in many other tunnels, that a larger area was excavated than that which the arch of brickwork was to occupy, but after the excavation was made to the required dimensions, a mass of the chalk fell in from the roof, leaving what Mr. Locke very aptly describes as a large dome-shaped cavity above the crown of the tunnel. To have completely filled up this space with pounded earth, would undoubtedly have been attended with some expense, and yet there can now be no doubt this ought to have been done, even had the expense been equal to ten times what it would actually have cost. It seems that a shaft was sunk down to the dangerous place, and the arch covered with stuff to the thickness of about 10 feet, and after this precaution on the part of Mr. Locke, and supposing this filling in to have been well pounded in layers of small depth, we cannot, considering the general want of experience in these matters, attribute much blame to the engineer for omitting to fill up the whole space. As we have said before, however, this example will operate as a caution in future emergencies of the same kind, and it will in all such cases as the falling in of a mass of earth above the excavated area of a tunnel, become the duty of the engineer to devise some means of protecting the arch from injury, seeing that if backing or filling in be resorted to at all, nothing short of a complete occupation of the space above the arch by solid stuff can be depended on to prevent future mischief.

As compared with other expedients for effecting this object, that of filling up the entire cavity has our decided preference; and we would recommend that in all such cases 2 feet thickness of pounded clay, rammed in layers of 7 or 8 inches, should be placed over the crown of the arch, as shown in the plate. This would effectually prevent the water from penetrating to the brickwork, and if clay could not conveniently be obtained, a water-tight covering might be made with moistened chalk broken into small pieces, and rammed or punnied in very thin layers. Whether chalk or clay, however, be used for this covering, it is indispensable that the whole remaining space to the top of the cavity be filled up with well pounded earth, either chalk or clay, whichever can be most easily procured.

Another important lesson derivable from this accident must not be omitted, namely, that, however firm the chalk may appear to be in any part of a tunnel, it is never advisable on any account to push the driving in advance of the brickwork, so as to leave any part of the roof of the excavation without support. Chalk is a proverbially treacherous material, and it is one with which, from its geological position, the most experienced miners have very little practical acquaintance. It is, therefore, important to preserve always a due regard to the possibility of a very rapid change in the solidity of

chalk in any excavation, and not to be misled by its firm appearance at any given point, into the belief that it will be equally so in the next fathom or even the next foot of the driving. We are of opinion, that, if the driving had not been pushed in advance of the brickwork, during the execution of this part of the tunnel, the original falling in of the stuff above the roof would, in all probability, never have taken place.

Mr. Locke informed the jury on this inquest, that, in every other part of this tunnel, and in all the other tunnels on this line, the brickwork entirely filled up the space which had been excavated. According to this, no pounding was required, or at least so little that it was not worth mentioning. However this be on the South-western railway, there are many cases in other lines where a considerable space intervenes between the brickwork and the solid earth, which has been filled up with loose stuff very imperfectly, if at all, pounded. Now the certain consequence of this neglect is to occasion unequal settlement of the loose stuff upon the brickwork of the arch, which, being thus deranged in its equilibrium, a fracture is almost sure to take place. A solid filling-in of pounded earth, on the contrary, equalizes the pressure upon every part, and has rather a tendency to strengthen than to weaken the arch, by pressing the whole mass closer together, and throwing it into a more solid and compact form.

The late accident in the Waller's Ash tunnel, adds another to the already strong reasons for the instant examination by the Board of Trade into the state of the cuttings, embankments, tunnels, and bridges of the existing railways. Our warnings to this effect may be disregarded, but they shall nevertheless be given, under a strong sense of public duty, no matter what odium we may incur from some whose censure is more to be coveted than their praise. Certain we are, that the honourable, upright, well-judging part of the profession will not only agree with us, but will thank us for our exertions, directed as they are by a sincere desire to elevate the dignity of the profession, and to see it practised in a spirit of such high and honourable independence as to scorn at once the petty meanness of gaining favour with directors, or gaining temporary distinction for sleight-of-hand rapidity of execution, at the sacrifice of that enduring strength and solidity which ought most particularly to distinguish the engineering works of the present day.

H.

ON THE PRINCIPLES AND ADAPTATION OF EGYPTIAN ARCHITECTURE.

THE encouragement of art, joined with the facilities offered in the present century for investigating every subject connected with science, have caused researches to be made in the most distant countries, and been the means of forming a comparison of the manners and advancement of different nations. The works of the Greeks during the age of Pericles have been undisputed both for their chasteness and beauty, and afford at the present day the ground-work for the talents of the architect and sculptor. The unity of their proportions in architecture have frequently by adaptation to modern usages and customs been ruined, and the simplicity of the sculpture, which invariably formed a part of an edifice, now too often made the subject of unwonted display. We cannot make the same comparison as regards the Greeks and the ancient Egyptians, who, though they availed themselves of the knowledge of their predecessors, greatly advanced, by a study of nature aided by their own invention, the true principles of art. The pyramids of Gizeh may rank amongst the most ancient labours of a civilized people: they cannot boastof constructions equal to the Pantheon or to St. Peter's at Rome, but the skill with which they were raised, with which every stone was cut, brought from the quarry, and laid in its destined position, establishes, in the result, the advancement of mechanical power. The material for the casing of the chambers of the Egyptian works is of red granite, brought from the cataracts of the Nile, and its stupendous blocks were so firmly united, that the insertion of a knife in the joints is now impossible. Various discussions have arisen as to the purpose for which these colossal masses of stone were erected, but from a knowledge of the mythology of the Egyptians, and their care for the preservation of the human body, there can be little doubt they were erected as tombs; each pyramid possibly for a single monarch or ruler. After the body was conveyed to its destination, great care seems to have been taken to secure effectually every entrance passage to the chambers; there can be little doubt that each side was furnished with polished casing stones (the various opinions relative to the finishing of the great pyramid being now set at rest by the late researches of Colonel Howard Vyse), presenting to the beholder an object of veneration and wonder. A circuit wall in most cases encompassed the platform on which they were raised, and in the immediate vicinity were excavations in the rock, used as burial places. Among the most interesting of these excavations was one lately made by Colonel Howard Vyse, and denominated Campbell's tomb: this contained a sarcophagus, covered with a semi-circular arch, showing that the principle of the arch was known at a period many centuries before the building of the Cloaca Maxima, which is generally considered the most ancient example of the arch.

The various temples on the banks of the Nile show the successive states of the arts in Egypt: we may be led to suppose that the purer style of Egyptian architecture, as well as sculpture, was of a period posterior to many of the existing temples in that country; and it is to be regretted that much valuable sculpture has been passed over, whilst that of inferior execution has been more accurately drawn and described, from a mistaken idea of its being of a prior date. Undoubtedly, the Ptolemaic period of Egyptian arts is replete with many beautiful and varied specimens; the ruins of the temples of that period show much invention and graceful detail, but they bear the mark of that degeneracy from a remoter time. Similar to the works of the Greeks after they were conquered by the Romans, or to the works of that nation, when, by the effect of the Gothic war, the arts had been neglected and their former purity innovated, or, to form a comparison to a more recent day, they may be said to be similar in point of good taste to the innovations on the simple beauty of the Gothic forms during the Elizabethan period of art. It must then be in the time of the Pharaohs that we can only seek for the sublime character of Egyptian architecture, and form thereon the basis for its true principles, considering at all times when its simple and severe character is adapted for the peculiar invention or structure of any edifice. The decoration and detail of the temples of this period prove how successfully the architect adapted the forms of natural objects to the embellishments of any portion of an edifice: the shafts of most of the columns appear composed of reeds or stalks

united by horizontal bands, the graceful and elegant form of the capital, representing in *contour* the full blossom or bud of the lotus flower. The simple form of this capital, which more particularly belonged to the time of the Pharoahs, received many alterations during the Ptolemaic period, but the specimens at Philoe prove that the variation in form has been often the result of great invention and taste. The capitals to the portico of the great temple at Dendara, are composed of the head of Athor (the Egyptian Venus). From the period that this temple was erected, this, again, was doubtless an innovation, and an adaptation of form ill-suited to its locality. The propylæa of the temple at Luxor are covered with beautifully sculptured intaglio, and on either side of the central doorway are seated statues; (many figures in a similar position have occupied the same situations before the entrance of a temple). Nearly in face of these were also two obelisks, a feature peculiar to Egyptian architecture, and always bearing the most valuable historical record: one of these interesting monuments still retains the position so well adapted for it: the other has been removed by the French nation, and like the obelisks at Rome, at present appears a solitary object in the centre of a piazza, conveying more to the mind the idea of a trophy of the conquest of a great nation than the architectural embellishment of a city.

The decoration in painting, which by the dryness of the climate has been so happily preserved, and which, in the tombs of the kings at Thebes, has surprised every beholder, shows how unity of form was at all times preserved in articles of furniture, ornamental clothing, &c.: the mythological representations are executed with the greatest care, and the paintings, both of historical and domestic subjects, if we except the knowledge of perspective, possess great beauty of composition.

The country of Egypt containing so rich a mine of art for the study of an architect, its antiquities cannot be too closely investigated. And without a servile imitation of any particular monument, its more beautiful forms may be carried to situations that may at the present time be best adapted for them; the justness of the proportion of every feature cannot be too strictly followed; its variation and proper adaptation must alone result from the effect of study. The architecture of Greece and Rome has been carefully measured and delineated, and we may boast of many beautiful specimens of design in either style; but the true principles of Egyptian art may yet be successfully applied in many situations where the utmost simplicity of form is required.

F. A.

SEA AND RIVER EMBANKMENTS.

These works, designed either to reclaim lands from the sea, or to protect from its ravages land hitherto beyond its reach, are common on the low and exposed coasts of this country, and in the estuaries of all the principal rivers. In many parts of England blocks of hard chalk, or such other stone as the locality will furnish, are laid in a rough kind of pitching or pavement to protect the base of the earthen wall or embankment. The stone work has usually a considerable slope towards the sea, and the bank is nearly perpendicular, so that the curve which would most nearly coincide with the surface of the pitching and the face of the wall, is of that parabolic form into which the shingle of a beach is observed to be thrown by the waves acting upon it. This form offers a far more effectual resistance to the force of water than the upright scarp which is sometimes given to sea walls; it is, in fact, following the course prescribed by nature, presenting to the wave an inclined surface, on which it will roll and expend itself with comparative innocence, instead of a steep abrupt barrier, against which it would dash with its whole force, and at length undermine and carry away.

The method we are about to describe for securing the base of sea embankments by means of any rough stones, even when round and quite unfit for building, has been extensively practised in the north of Scotland, and will be found useful in any part of the country where a moderate supply of any kind of stone can be procured, and where timber is not very expensive.

Fig. 1, is a cross section of part of an embankment, showing also an open coffer, provincially called a creel, into which stones are loosely piled to the top, as shown in the section, and being placed near the foot of the embankment, the seaward-side of the creel is protected by a slope of the same kind of stones terminating in the flat beach. These creels are usually made of fir poles, about 14 feet in length, of the dimensions shown in the section, secured to upright posts by trenails, with cross-pieces at the ends. Four poles, 7 or 8 inches diameter, are sufficient to form each side of the creel, as there is no necessity for placing them close together, the stones being too large to fall out through the openings in the sides, and even if a few should so fall out, it is obviously of no consequence.

These creels save a good deal of stone, because the embanked earth comes directly upon the inner side of the creel, and renders a slope of stone unnecessary on that side.

Fig. 2, is a plan of the creel, and fig. 3, shows the application of the creels to keep the slopes of railway, canal, and road embankments from slipping, and we are convinced that they might often be used with advantage in these works. In some of the railways it is said that embankments have slipped out at the base to two or three times their original width. In such cases the creel would have prevented any giving way at the base, and, unless the embankment were constructed of very bad stuff very hastily and injudiciously thrown together, no slip would have taken place.

When the base of an embankment is subject to the occasional wash of the waves, a very simple protection (see figs. 4, and 5) may be constructed at its base of almost any kind of wood, that which we have generally used for the purpose being the thinnings of Scotch fir, 5 or 6 inches diameter at the base, tapering to 3 inches at the smaller end. These may be had in lengths of 14 feet for about 2*s*. per dozen, and should be cut into pieces of about 4 feet in length, the smaller ends to be used as piles, and the stump ends to be sawn through the middle, and used as a cap or coping for the small piles.

The piles are to be driven about a foot into the ground, at the distance of about a foot from the base of the bank. They are not to be driven close together, but with interstices between, as shown in the plan, fig. 5. The larger split pieces are then to be spiked down with a long nail passing into each pile, as shown in the section. This very simple work has been found to break the force of the spray or splash from the waves, and to protect from injury the bank, which, without something of the kind, would speedily be washed away. The cost of driving and fixing these piles is a mere trifle, an active man being able, with ease, to put up about 40 yards in length per day.

H.

SEA EMBANKMENTS.

Fig. 1.

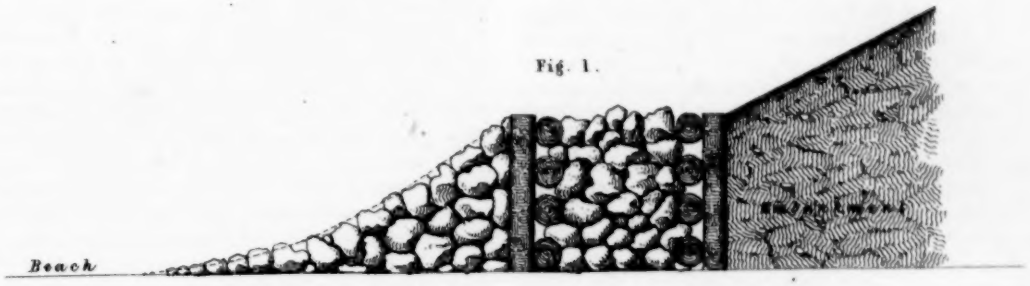


Fig. 2.

Fig. 3.

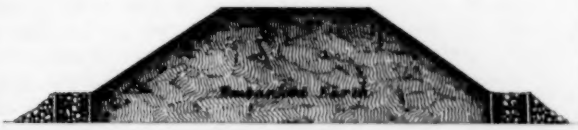


Fig. 4.

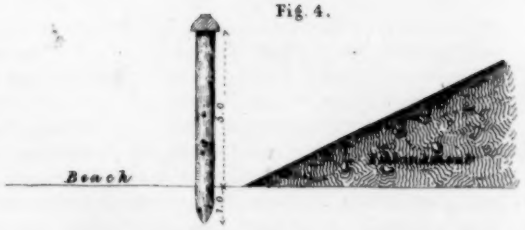
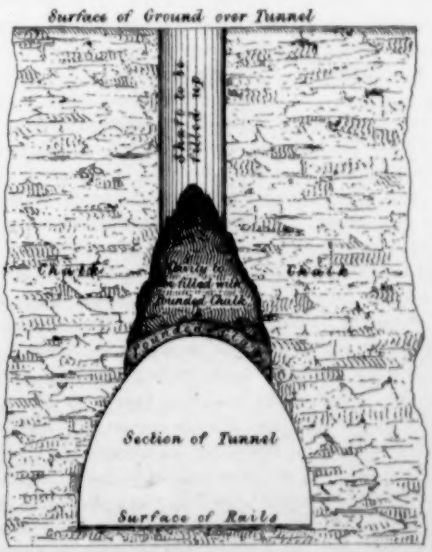


Fig. 5.

SLIP IN WALLERS ASH TUNNEL.



J. Weale, Architectural Library 59, High Holborn.

PUBLICITY TO ARCHITECTURAL COMPETITIONS.

WHAT with additional churches, and with other public works, competitions among architects have become very important matters, both with the profession and with the public; and hence it is necessary, in order to insure the latter proper success, to give them every publicity possible. We do not know how far the present mode of competition is unfair; but never a month elapses without our receiving complaints on the subject. It is by no means impossible that many of these complaints are produced by those candidates who make themselves sure of the jobs, and are disappointed; but some of them must be well founded; and we have heard of several instances in which the architect was selected before the competitors were decided on, and before the competition was advertised; in which cases that must have been a mere blind. We have neither room nor inclination to cite all the cases which we have heard of; these must form but a small fraction of the whole, and it would be injudicious to notice single instances; so that we shall content ourselves with the bare statement which we have given of the facts.

Publicity to these competitions, whatever may be their nature, is a subject upon which there cannot be two opinions; and, though it may be the interest of the parties to conceal such as are unfair, these are the very ones with which the profession and the public ought to be best acquainted. If all is, as it seems, right above board, nothing further is necessary than simply to advertise for what is wanted, only it must be circumstantial enough, and due publicity tendered to it; nor must a single iota of information be given to any of the candidates which is not given to them all. When it is fully ascertained that the competition is a perfectly fair one, it is doubtful whether it is a legitimate subject for criticism by the journals and other publications, until it is determined; but in this case the successful candidate ought not to be tied down to the particular line of architecture, and the individual character of the building. If the criticism can be trusted to as quite unbiassed, then this is the time for it, so far as the adaptation of the building to its place and purpose is concerned. But in too many instances the criticism of the journals is either most unfair, or it is no criticism at all. Some of the parties have access to the said journals, and as they are venal enough, there are means of no very legitimate description for securing their approbation and applause. It very frequently happens, too, that those parties which have most influence with these journals are the least deserving, because men of sterling abilities are apt to trust to that, without reflecting, that persons possessing them are the least prone to covet favour with the public in any other way. Therefore, as there is always a danger, and, in many instances, a certainty, that criticism is unfair, and on that account misleads the public, the suppression of it would be a matter of no small value, notwithstanding the arguments that may be made use of in favour of it.

If the competition is unfair, then the grounds of the unfairness cannot be too clearly stated, nor can the parties to whom they belong be stamped with sufficient obloquy, as being the worst enemies, both of the professions and the public.

Unfair dealing may run through all the steps of the proceeding, from the choice of the situation to the finished building and its decorations: and, in all of these, there may be parties influenced by other motives than the proper one, whether it is possible to know and state those motives or not.

In the choice of the situation the architect is rarely consulted, even in cases in which there is no competition; and, where there is to be a competition, this is not possible, at least in any thing like an efficient manner. It is plain that, in order to give the best effect to the structure, which can be done only where there is a choice of ground, the architect ought to be consulted as to which is preferable, because then he has the advantage of situation, as well as professional skill, in obtaining the most effective *tout ensemble*, whereas, if he is confined to the mere building, there is only one element of this, and he must be governed by this element alone. Now, in many public buildings, as, for example, in a new church, it is very often the interest, or, at all events, the desire of influential parties to have the building, not in the place where it would be best on the whole, but in that which is most in accordance with their own interest or taste. They may canvass, and sometimes coerce the rest of those interested for the adopting of this their favourite spot; and, to prevent the bad effect of this, there is nothing but calling in the assistance of the architect, or some other person or persons competent to judge of the matter, and yet having no interest in it; and, as has been stated, the architect, where there is to be a competition, is not available; for the question, "Which architect is to be employed?" arises; and this is tantamount to giving the execution of the work to him who decides on the situation.

Another instance in which the individual structure may be vitiated, and great mischief done to the public and the profession, especially to the junior, and, therefore, most energetic of the latter, is canvassing for votes in favour of one of the competitors. This may be done by the competitor himself, and that in so concealed a way, that it is not easily discoverable; and, therefore, the usual method is, to canvass through the medium of friends. We could mention several very recent instances of this; and though we shall not name either the occasion or the parties, we cannot help saying, that it is most unfair as regards the profession, and being so, it cannot be the most advantageous for the public. Still, so apt is it to be the case, that if any competitor has an influential friend, or influential friends, in the committee, commission, or other body who decide on the merits of the candidates, it is usual for other professional men to state the perfect uselessness of their competing; because, whatever may be the relative merit of their plan, the patronised candidate is sure to be employed.

A third method of vitiating competition, and one which is an especial clap-trap for the indolent, is by means of the drawings. In the case of these, it is not the best and most efficient architect who is the most successful,—it is he who produces the most stylish drawing; and so much is this reduced to a system, that making drawings for the profession is in itself a trade; and we could mention more than one well-employed architect, who owes his employment solely to the drawings of a man, who does not make as many shillings by them as the architect makes pounds. Strange as it may seem, this mode of imposing upon the public is very common; and though it does not impose on the better informed part of the profession, it makes them hold back, and not compete. Obvious as the evil of this is, it is exceedingly stubborn, and difficult to be eradicated. Plans and sections are the proper drawings, and the only ones that ought to be allowed to compete; but the public, and even the committee, do not understand plans and sections in such a manner as to know what sort of building will result from them. Thus, perspective drawings are resorted to, and they are the ones by which the deception is perpetrated. The public, or

their committee, prefer not that according to which the best building would be constructed, but the prettiest picture; and thus, they advertise for architectural subjects, but decide upon paintings.

In this may be embodied a deception in a pecuniary point of view. The price of the structure, as set forth in the plans and sections, may be exceedingly moderate; but, when executed after the picture, it may be just as expensive: and we believe we are correct in stating, that there are instances in which, by this means, the real cost of a building has amounted to several times the original estimate. One would naturally suppose that this could not well happen, hedged in as the execution is by the guardianship of a committee; but it actually does happen, and the bringing of it about is a very simple matter, but a matter which no guardianship of committees can prevent. The evil is in the incapacity of those who judge of the competitors; and, as the case stands at present, there are many ways of getting the better of that protection which should be afforded to architects of merit. At present there does not appear to be any cure for this; and the only proper cure that could be applied is a parliamentary one, the effect of which, to say the least of it, would be very doubtful. Where the public is inefficient, the usual mode is to employ commissions; and these have but seldom the full effect intended, and often a very different one; and, perhaps, the best thing that could be done with regard to this would be, to insert in some general parliamentary act a clause, inflicting a penalty upon both parties, in every case where the cost of contracted work exceeded that stated by the contractor, unless in cases where there were departures from the original estimates of the competition; and these, also, should be within parliamentary control. Some attempt has been made to remedy this evil, by allowing each contractor to present only one perspective drawing, from which all colour except the ink is to be excluded; but this will not be general, and, consequently, will fail, unless it is enforced by a legislative enactment, and a penalty. There are numerous means by which a contract may be vitiated, but those that we have mentioned are the principal ones, and, consequently, the ones to which the attention of the public ought first and chiefly to be directed.

Our correspondent Ion proposes the publication of all the cases of competition as a means of correcting the evil. This might be of some service, but we fear not nearly so much as he anticipates, considering the difficulty there would be in collecting the information which he wants. He has the kindness to propose that we should every month devote a page to the subject, not of competitions in the metropolis merely, but everywhere throughout the three kingdoms. If we could obtain authentic information we should be glad to devote several times the space which Ion mentions to this kind of intelligence; and if the details were at once authenticated, for our own satisfaction, by the signature of one who seems trust-worthy, we should be glad to give them at greater length. But there are difficulties in the matter, of which Ion does not appear to be fully aware. In the first place, it would be very difficult to procure the information fully and accurately, because the furnishing of it depends upon others, and not on us; and in the second place, it would have the air of so many advertisements, and be charged with duty as such. Now, though we would willingly admit it into the body of the work, and advertise it very cheaply, yet we could effect no reduction of the duty on the advertisements; and it is doubtful whether the parties interested, that is, the parties advertising for the competition, would do this. If the competition were a fair one, then they would do it, and it would be their interest to do so, because, our readers being chiefly professional, it would pass into the hands which are most desirable. But, as we have said, a portion, and that a very considerable portion, of the advertisements for competitors are not fair, and in these cases the advertisers would reluctantly pay an additional expense, unless indeed it were to conceal the inforcers of the competition; and if there were such a list, and advertisers did not avail themselves of it, that would be strong evidence of something in the case which they did not wish to come above board. Thus, in every view of it, the scheme recommended by Ion has the appearance of being a very useful one to the profession and the public, whatever it may be to mock-advertisers, who mention the subject competed for the purpose of concealing jobs. Therefore, we shall readily open our columns to it, in the hope of advantage to the profession and the public from our so doing; and next month we shall be happy to begin. In the mean time, we thank Ion for communications, and shall be very glad to receive similar ones upon all subjects which require and would be benefited by publicity. What he proposes we look upon as indispensable to the doing of justice to the public and the professions, how ill soever it may be relished by interested parties. The interest of the public consists in obtaining the very best structure both for use and for ornament, executed in the best and most durable manner, and at the lowest possible expense that will afford a fair profit to those engaged in it; and lower than this there should be no attempt to have it, otherwise the result will be inferior in some respect or other, and an opportunity of doing good and being ornamental will be thrown away. In so far as professional men are concerned, the evil arising from the smuggling system, and the advantages that would result from an opposite one, and do result from it when fair and open, would be much greater. By a fictitious competition, that is, one which is really no competition at all, the very men whom it is most desirable to bring forward are held back, and thereby greatly and directly injured, and the public also suffer, though in a less direct manner.

A competition always presumes that the parties seeking that competition wish to obtain the most effective man possible in the way both of talent and of energy; and the competitors are low indeed in the scale if the pecuniary profits of the individual case are all that they aim at. Competitions rightly managed are the best and most legitimate means whereby young, and especially young men of talent, can bring that talent before the public; and they are also the best means of getting the public well served. If a competition in name is not also one in reality, these advantages are lost, and corresponding evils are sustained. In such cases the favourites—those who are already known and well-accepted, are the parties chosen; and the new men have no opportunity of making themselves known, even though their abilities may be, as they often are, far greater than those of the favourites. It generally happens, too, by these unfair means the very highest talents and the greatest energy are lost to the world. If a comparatively dull fellow does not succeed one time, he tries again in the hopes of better success another time; and generally he is of such calibre as not clearly to see why he failed, and so obtuse in his feelings that failure is not very keenly felt by him, and does not scare him away from competition, or damp his spirits so much as in the case of a man of more talent and feeling. The injury done to the public by repressing the most talented men of the profession is a very severe

one, as it prevents public works from being done in the way that they ought to be done; and thus, where there should be good accommodation, there is no accommodation at all; and where there ought to be beauty, there is nothing but deformity. Architecture is, we are sorry to say, not the only subject upon which the public suffer from this cause; but, suffering in one case, though it may conceal suffering in others, does not in any way remove that suffering; upon this principle, the architectural evil done to the public is just as great as it would be if everything else was quite correct, only it is not so glaring as if it stood alone in its deformity. Its not standing alone, but being connected with the cases of other subjects, is indeed one of the causes why it is so mischievous; for in proportion as the pernicious part of any subject is hidden from the public, the mischief of it is increased, and rendered more obstinate or difficult to be moderated. Although, therefore, there were no farther injury in any case than that we have just now stated, that would be enough to explode and scout it from the practices of society.

But the great evil consists in reducing the class of architects, and reducing it to the least efficient portion of the whole. Architecture is not to be learned by studying in the office of even the very best architect; for, in order to secure him in his superiority, he always keeps back the most important part, whatever may be the nature and purpose of the works in which he is engaged. Therefore, public competitions are the means, and the only legitimate means, by which the corn of architecture can be sifted from the chaff; and unless they are resorted to where there is more than one chaff for every grain of corn, the chance is, that chaff will be the regular portion of the public. If, however, the different candidates are brought forward to a proper competition, in which the talents of each shall have fair play, justice is done to them as well as to the profession of which they are members, and effective and honourable members, instead of hewers of wood and drawers of water, as they necessarily become when the case is the opposite.

Thus, in every view which can be taken of it, the plan recommended by Ion is a most valuable one, and ought to be carried into full execution. As already stated, we shall be most happy to lend the pages of our Journal, and also our talents, such as they are, to the forwarding of it; only, getting the requisite information is, as we have already stated, very difficult, and getting correct information is impossible. Still, however, Ion does not deserve the less gratitude on this account, but rather the more, for having brought forward a subject which is in many respects new, and in all respects useful. Such plans as he proposes, if they can be carried into proper effect, are the very best means of progress in all important and public professions and occupations of that line by which they are at present controverted; and he who provides a subject has higher merit than he that improves one.

PROCEEDINGS IN PARLIAMENT RELATING TO ENGINEERING.

LIST OF PRIVATE BILLS BROUGHT INTO THE HOUSE OF COMMONS.

(*Continued from page 77.*)

SALTCOATS HARBOUR. The object of this Bill is to provide for the better regulation of the Harbour of Saltcoats, in the county of Ayr, and to vest the harbour in Robert Cunningham, Esq., and to enable him to levy tolls therein.

ARDROSSAN HARBOUR. The object of this Bill is to vest the Harbour and Docks of Ardrossan in the trustees of the late Earl of Eglinton, and to empower the proprietors of the harbour for the time being to levy new rates and duties, and to improve the harbour.

PIEL PIER AND HARBOUR. The object of this Bill is to enable Sir Hesketh Fleetwood, Baronet, to erect and maintain a Pier and other works in the parish of Dalton-in-Furness, in the county of Lancaster, and to improve the Harbour.

THAMES HAVEN DOCK AND RAILWAY. The object of this Bill is to extend the term for the purchase of lands and completion of the works of this Company.

YARMOUTH AND NORWICH RAILWAY. The object of this Bill is to incorporate a Joint Stock Company for making a Railway from Great Yarmouth to Norwich, in the county of Norfolk.

SAUNDERSFOOT HARBOUR. The object of this Bill is to enable the Saundersfoot Railway and Harbour Company to make a Floating Dock at Saundersfoot, in the county of Pembroke, and to vary some of the provisions of the former Act.

ELLESMERE AND CHESTER CANAL. The object of this Bill is to amend some of the provisions of the former Act relating to the Ellesmere and Chester Canal, and to enable the Company to raise a further sum of money, and to act as carriers on their canal.

SAUNDERSFOOT RAILWAY. The object of this Bill is to authorize the Saundersfoot Railway and Harbour Company to make an extension of their present Railway, and also to make two branches from it within the county of Pembroke. The Bill also extends some of the provisions of the Act relating to the Company.

BRISTOL AND GLOUCESTER RAILWAY. The object of this Bill is to enable the Bristol and Gloucester Railway Company to raise some more capital, and to purchase, by consent, a portion of the Line of Railway of the Cheltenham and Great Western Union Railway Company. The Bill also empowers the Company to lease their Railway, and to extend the term limited for acquiring lands and completing the works.

BRISTOL FLOATING DOCK. The object of this Bill is to repeal an Act of the 16 Geo. III., for regulating the Quays within the Port of Bristol.

DROGHEDA HARBOUR. The object of this Bill is to improve the Port and Harbour of Drogheda. It repeals the existing Acts (30th, 37th, 48th, & 50th Geo. III., and 7 & 8 Geo. IV.), and vests the Harbour and Works in the Commissioners to be constituted under this Act, and provides for keeping on foot existing engagements and actions.

BIRMINGHAM AND DERBY JUNCTION RAILWAY. The object of this Bill is to enable the Birmingham and Derby Junction Railway Company to raise some further capital.

GOSPORT PIER. The object of this Bill is to incorporate a Joint Stock Company for making a Pier at Gosport, in the county of Southampton.

MERSEY CONSERVANCY. The object of this Bill is to preserve the River Mersey from encroachments.

STOCKTON AND HARTLEPOOL RAILWAY. The object of this Bill is to incorporate a Joint Stock Company, heretofore constituted under a Deed of Settlement, and to provide for maintaining and

better regulating the Stockton and Hartlepool Railway, constructed by that Company.

FAVERSHAM NAVIGATION. The object of this Bill is to make provision for improving the Navigation of Faversham Creek, in the county of Kent.

LOUGH FOYLE DRAINAGE (the Lower Level). The object of this Bill is to amend an Act of the 2nd Victoria for draining and embanking certain Lands in Lough Swilly and Lough Foyle, in the counties of Donegal and Londonderry, so far as the same relates to certain parts of the said Lands in Lough Foyle.

BELFAST AND CAVEHILL RAILWAY (Road and Shipping place). The object of this Bill is to enable the Belfast and Cavehill Railway Company to construct a Road and Shipping place connected with the Railway, and to take Quay Dues.

WARWICK AND LEAMINGTON UNION RAILWAY. The object of this Bill is to incorporate a Joint Stock Company for making a branch Railway from the London and Birmingham Railway at Coventry, to communicate with the Towns of Warwick and Leamington, in the county of Warwick.

LONDON AND CROYDON RAILWAY. Grange Road Approach (No. 2). The object of this Bill is to enable the London and Croydon Railway Company to make an approach to their Railway in the parish of St. Mary's, Rotherhithe, in the county of Surrey.

BURNTISLAND AND GRANTON PIER FERRY AND ROAD. The object of this Bill is to provide for constructing a Low Water Pier and necessary works at Burntisland, in the county of Fife: and establishing a Ferry between the same and Granton, in the county of Edinburgh; and for enabling the Trustees of the Kirkaldy District of Roads to construct a piece of Turnpike Road, forming communication between the Pier and Kinghorn.

FIRTH AND CLYDE NAVIGATION. The object of this Bill is to enable the Firth and Clyde Navigation Company (incorporated by an Act of the 4 & 5 Victoria) to make additional reservoirs, and to purchase the Firth and Cart Junction Canal, and to act as carriers.

LOUGH FOYLE DRAINAGE (the Upper Level). The object of this Bill is to amend an Act of the 2nd Victoria for draining and embanking certain Lands in Lough Swilly and Lough Foyle, in the counties of Donegal and Londonderry, so far as relates to certain parts of the Lands in Lough Foyle.

SHEFFIELD AND ASHTON-UNDER-LINE AND MANCHESTER RAILWAY. The object of this Bill is to give to the Sheffield and Ashton-under-Line Railway Company some further facilities for raising money.

SCIENTIFIC SOCIETY OF LONDON.

THIS society possesses several advantages, even over those which are of far higher name, and longer standing; for it has none of that weakness of old age which belongs more or less to the older societies, and paralyses their long-sounding and once respectable names. It seems to be the fact that all human objects and establishments, as well as all sublunary substances, have their appointed periods, which they cannot pass, or if they do pass them they resemble the men from seventy to eighty, mentioned in the sacred volume, and labour out the remainder of their days in weakness and senilitude. We could mention societies of which this is the state, though they were once very stimulating and highly useful to the sciences. The reason seems to be this:—The old society adheres to its ancient forms and modes of proceeding, long after the rest of society has got far before it in knowledge, and still farther in inquiry. If the number of members is unlimited, if the ground of admission is the will of a meeting, or a committee, and if the object of aspirants to membership is the *eclat* which the title of the society appended to their names gives them, then assuredly the society is in a state of decline, and though its members may drivel on for a time, it sinks lower and lower day after day, and year after year, until it at last goes out in utter insignificance. This, we will admit, is a sorry termination for that which may have been eminently useful in its day; but still, the necessity of all nature is upon it, and it must yield to its fate.

Therefore, we are always glad to hear of the establishment of a new society, and especially of one of a new class; for though it may err in the outset, it seems right itself, and passes through its period of activity with credit to itself and usefulness to the world. The Scientific Society is one of this description. It is still in its infancy, and its members are few, but they are all in the energetic period of life, and they do not content themselves with the beaten path, but strike out new ones. In this they may, indeed must, be erroneous at the beginning, and for some time afterwards. But it should be borne in mind that the road to truth is paved with error, and that every man who devotes himself to an original subject in an original manner, must have his period of error before experience can guide him to truth. This is the case with an individual who confines himself to the retirement of his closet, as well as with him who comes abroad, and endeavours to discuss the subject along with others, agreeing or disagreeing as it may happen; and disagreement is the more valuable course, for if the disputation is carried on in the right spirit, the parties reciprocally serve as the flint and steel in illuminating each other. Upon due consideration of these circumstances, we feel inclined to give the Scientific Society every publicity in our power, by giving brief statements of its proceedings, or anything else which may appear to us calculated to forward its main purpose. The plan of proceeding is to read a paper, and to follow that paper by a discussion on its merits, carried on with the most perfect freedom, and yet in the most kindly spirit. The following paragraph will show the mode of procedure.

"The meetings of this society on March 16th, and April 6th, were occupied by further statements on the 'triune classification of science,' and embraced respectively the vegetable and mineral kingdoms of nature. The former has already been recorded; the beautiful analogies which exist between the classes Vertebrata and Exogenæ, Annulosa and Endogenæ, and Mollusca and Acrogenæ, were successively noticed, and the tests of the system recorded; but, on the occasion of the latter meeting, a subject altogether new was submitted, and gave rise to a very animated discussion. It has long been known that there is an affinity between the rays of light and certain gaseous elements—the red ray with oxygen—the yellow ray with nitrogen, and the blue ray with hydrogen; but at the meeting in question, Mr. Charles Moxon contended that this connection extended further than to mere colour, that the combined effects were evinced in material bodies, in the respective characters which they bear. He adduced a review of the prevalent colours in the mineral kingdom, and from these, assigned a place to each, exactly in accordance with the present chemical system

of mineralogy. Now, although a certain degree of theory must exist in the present stage of inquiry, from the complication of elementary substances, all of which must be resolved within smaller compass, according to their true qualities; yet, it was clearly the wish of this meeting, that the subject should meet with a careful consideration: as the identification of Mr. Moxon's idea, founded upon such information as we already possess upon the science, would lead to the recognition of an alphabet as it were, for facilitating this as well as the higher departments of the natural sciences, and complete the proof of the prevalence of the triune order in created beings."

The triune principle, or fancy, or whatever it may be called, which forms the basis of the papers at present under reading and discussion, has been made the subject of too much respect and veneration by some parties, and of most unseemly ridicule by other parties. From the very earliest accounts, all nations which have had a system of divinity, have had more or less of the triune principle connected with that system, and though in their view of it, it is one of the mysteries which cannot be explained, yet attempts have, in all ages, been made to bring it down to earth; and thus make that an emanation, as it certainly is a production, of divine power. The parties who have done this have not endeavoured, like the materialists of modern times, to bring down Godship to the earth, but, on the contrary, to raise earth to the station of Godship; and this, though not so impious as the other, is yet at variance with common sense. Others, seeing this, and possessing more wit than wisdom, have endeavoured to turn the triune principle into ridicule; and there are a few who have been eminently successful in this way, without the slightest desire of being so. Several years ago there was sent to us, from Shrewsbury, a small volume, written by an inhabitant of that town, and if not poetry, or even accurate rhyme, it is broken into lines of unequal length, which is all that some parties mean by poetry. This book, or waste paper, or whatever else it may deserve to be called, is intitled "Lays of the Minstrel of the Triune Power, by the Cupbearer," and certainly there never was so mixed a cup presented to society, or any member of society, by any "cupbearer" whatsoever.

We shall not make any formal quotation from this curious book, in which there is no passage expressing anything that we could call a meaning. We may mention, however, that the same words, "These vocal lays," or which, we suppose, means the same thing, "These vocal strains," begin every line through four consecutive pages; and that, in another part of it, the words, "This flying Rollis," repeated nearly as often. We give one or two couplets of the first;

> "These vocal lays, cheaper indeed than dirt,
> These vocal lays can do no creature hurt."

And again,

> "These vocal lays will tie a hinnel down,
> These vocal lays will clear a parish town."

Yet again,

> "These vocal strains will make a sister stare,
> And be a guard from all of shade and snare."

Still again,

> "These vocal strains, examine them who will,
> Will the whole world, and will your bosom fill.
> These vocal strains have purged all filth away,
> As we so long have hoped, and to day,
> These vocal strains will cause both joy and sorrow,
> But I shall tell more after to-morrow.

Such is a specimen of what the author no doubt considers as the highest encomium possible on "These vocal lays," by which he means his own book; and he must be a very whale of nonsense who would wish for any more of such quotations.

Having given this quotation of what is no doubt regarded by its author as the very acme of approbation, expressed in the most faithful manner, and in the most exalted style, we shall give one or two sentences, or rather subjects of sentences, in which the intention of the author is evidently the opposite; and having given these, we shall leave our readers to judge which is the more ludicrous of the two.

"It is not easy," says an anonymous writer, "properly to estimate the veneration which mankind have for the number three, or at least which they should have for it, considering the very important services which it renders to them. There is not a word in the language, not even the 'I' of a egotist, or the 'We' of a periodical editor, at all comparable with it in importance or frequency of application. To give a few instances: three is of great consequence in flags, because, without it we could not get the tri-colour, or flag of revolution; secondly, it is indispensable to pashas, because, but for it, he could not have the high honour of being the pasha of three tails; thirdly, it gives the greatest stability and honour to a stool, by making it 'stand firmly on its pins,' which no other contrivance can accomplish, and also converts it into a tripod, or stool of prophecy; fourthly, it is of the utmost service to a parish beadle, as being the only means of crowning him with a three-cornered cocked hat; and we may add that, in this country at least, military honours, and even majesty itself, would be shorn of their beams, if the number three were struck out of the vocabulary; fifthly, three includes everything, for every solid or substantive existence has length, breadth, and thickness; and every action or succession of actions has a beginning, a middle, and an end, so that, strike the word three from the vocabulary, and the world will be a waste and direful desert."

It will be manifest, from these opposite quotations, that excessive praise has the same effect upon this most important word as direct and intentional censure; and, therefore, part of it at least is the very best name that can be given to a society which is avowedly to treat of all subjects. It is, however, with the one part of the name only that we are so much in love, and perhaps the other is put in in order to show that the very best thing upon earth is of such a nature as that it can be degraded by having an improper name given to it. The objectionable part of the name is the syllable une, which means one, and in whatever sense it may be used, it invariably has an allusion to the Almighty, and by having this allusion it is blasphemous. It means three in one, which is always an exceptionable name, except when applied to the three persons of the Godhead, who are the only three in one with whom we are acquainted; and therefore the application to anything not sacred of that name, which should belong to them only, is blasphemous, and ought never to be used. The love which is shown, or pretended to be shown, to other parties, by the application of the name, is merely a piece of show, intended to impose on the credulity of the thoughtless, and not to serve any useful purpose. As it is, however, it is the display of that sham fertility which is the characteristic of nominal greatness, of that mock power which belongs to persons of fancied greatness, and to them only; and they who admire it are only lovers of

sham fidelity, and not of truth,—admirers, not of that which is really valuable, but of that which is merely the result of vanity and frivolousness. The love of truth is not their ruling principle, but the love of themselves and their self-gratification, and if they are once gratified in this, they care for nothing else. If they but once can gratify themselves in this, they are men or women of the most exalted character, and they love the greatness of nature with all their souls. This is the grand principle of the love of men for the grandeur of what is great; and if once gratified in this, they are gratified in the highest degree, and care for nothing else. If they are thus elevated as men, they have no other thought, and are gratified, not beyond measure, but to its full extent. This is that which is sought by men of the most exalted character; and give them this, and the sum of their happiness is complete. Thus gratified, they are joyous beyond all measure, and there is nothing which can break in upon this happiness. If they once have such joy, nothing can break in upon the fulness of their gratification; for they are as happy as men can well be, and every enjoyment is theirs. They seek what makes them happy, and that only, and having found this, there is nothing more which they desire or can desire.

REVIEW.

A Treatise on the Application of Marine Surveying and Hydrometry to the practice of Civil Engineering. By David Stevenson, Civil Engineer.

This is a very clever work, and shows the author to be a man of the greatest talent; but it is one which does not admit of quotation, all the parts of it being so connected with each other, and bearing so directly on the subject whereof it treats. The first chapter or section of the book is on the subject of triangulation; of which it gives a clearer description than any book with which we are acquainted. It points out in a very clever manner the several parts of the subject: indeed it could not have been done in a better style. In treating of this, the river Tay is taken as the subject; and besides the common doctrine of triangulation, it discusses some points not alluded to in any other book. Among these, one is the general doctrine of triangulation, which we have never seen treated in so masterly a style; another treats of the peculiarities of triangulation, and a third on the influence of magnetism on the magnetic needle, which is somewhat of a novelty, as well as being very excellent in its other parts. The peculiarity consists in a disquisition on the needle when used for surveying, a matter which we have not hitherto seen so well treated.

The second section treats of base lines, in the same able style as the first; and the method of determining those intricate matters is well explained. The third treats of tide observations. It is a very clear account of a most intricate subject, and deserves the perusal of all who are fond of tidal speculations.

The subject of the fourth is soundings, which is treated in the same masterly style as the preceding ones. Sounding is a very important matter, because it alludes to one of the most important subjects with which the mariner is acquainted.

(To be continued.)

IRISH RAILWAYS.

We have received a number of pamphlets on the subject of Irish Railways, some proposing that they should be done by government, and others that they should not. We must admit that the central plane of Ireland is one of the best situations for railways to be met with in the world. It is nearly flat, and the limestone, of which it is composed, is of the firmest texture, and can be had in any quantity. Labour, too, is cheaper than in any part of Britain, or probably the world; an able-bodied man being obtainable for half the same expense as in England. In all physical properties, therefore, as well as in expense, the facilities with which a railway can be made are very superior, and the level nature of the country renders this one of the best means of transit.

Unfortunately there is an obstacle to the making of railways,—there is no money in the country to execute them in a proper manner; and the government, which is the proper power for doing them, will do nothing of the kind. The making of them by government would be by far the best plan; but that is no part of the system of our government, to which a government plan is hostile; with us, the construction of any thing of a public nature must be undertaken by private parties, who do it for their own advantage; and hence the whole must be done at the expence of individuals. This is bad in every case, and in the case of Ireland it is wretched. Still, however, bad as it is, it is the British or Irish system, and as such there is no getting rid of it. If Ireland admitted of a continental system, the same as obtains in countries where our system is unknown, it would be good, in like manner as all government systems are good enough.

We are anxious that the public should stand up for this measure, and a few of these railways would cost them but little, but unless done by government, they will not be done at all. Hence, notwithstanding the clamour which would be raised against them, the not doing them will be a most serious loss for Ireland, a loss for which nothing can compensate; and, therefore, no other plan ought to be allowed to stand in the place of a government one. But the outcry which would be made against this, or anything else done by government for Ireland, or for the Irish, would be very great; and it seems that, however well disposed, government are not allowed to execute even the best project for that unfortunate country.

SHORT NOTES.

Metropolitan Bridges.—Up to the adjournment of the House of Commons, at Easter, no fewer than 89 petitions, signed by an aggregate number of 16,668 individuals, have been presented during this session, praying that measures may be adopted for redeeming and extinguishing the tolls upon Waterloo, Southwark, and Vauxhall Bridges.

Tithe Commission.—It appears from the returns of the tithe commissioners lately presented to the House of Commons, that up to the 1st of January, 1842, they have confirmed agreements for the commutation of tithes, comprising a gross annual rent charge upon land in England and Wales, payable in lieu of tithes, to the

amount of £2,150,811. The labours of this Commission will furnish statistical information of great importance as to the value of all the landed property in this country, and as to the revenue derived by the church in lieu of tithes. It appears that, as far as the commutations have at present proceeded, the church has derived an advantage from the abolition of tithes. We gather this from the fact that the gross amount of annual rent charge for which tithes have been commuted up to January, 1841, is £44,150 in excess of the average amount of tithes, or composition in lieu of tithes and rates, during the seven years preceding Christmas, 1835, as appears from the present return.

INSTITUTION OF CIVIL ENGINEERS.

COMMUNICATIONS.

Description of a portion of the Works of the Ulster Canal. *By* Thomas Casebourne, *M. Inst. C.E.*

The Ulster Canal, which is described in this communication, was designed for the purpose of facilitating the intercourse between the west and the north of Ireland. It commences at the southern extremity of Lough Erne, in the county of Fermanagh, whence it extends for a length of 46 miles, and enters the river Blackwater, near the village of Claremont, in the county of Armagh, from whence there is an outlet through Lough Neagh to the ports of Newry and Belfast. The total cost of this work will amount to about £210,000, or £4,565 per mile.

Allusion is made to a proposed junction canal between the rivers Boyle and Shannon, which may be considered as an extension of the Ulster Canal westward, effecting a junction between all the navigations of Ireland. By its means the produce of the town of Boyle, and the agricultural district around it, would be conveyed directly by steam to Belfast and Newry.

At the time of this communication, the Ulster Canal was rapidly advancing towards completion; it was navigable up to Clones, a distance of 40 miles from its commencement, and would be opened to Lough Erne during the summer of 1841.

A description is given of the most difficult and expensive portion of the canal, which is situated at about six miles along the line from Charlemont. The length of this part is about three-fourths of a mile, and it comprises seven locks. The expense of construction, exclusive of the value of land, was £17,053 4*s.* 9*d.*; in order to diminish the expense as much as possible, the canal was contracted in width in two points, where the local impediments were considerable. The transverse dimensions of the canal are, 19 feet 6 inches at the bottom, 36 feet at the surface of the water, and 42 feet at the top of the bank,—giving a slope of 3 to 2 at the sides of the channel. The depth of water is 5 feet 6 inches in all the reaches, except the summit level, which is capable of containing 7 feet of water. The course of this portion of the line lay along the bottom of a steep ravine in a limestone rock, parallel with the channel of a mill-race adjacent to the river Blackwater; the mill-race was, therefore, diverted into the river between the first and fifth locks of the canal. Between the third and fifth locks the bed of the canal was formed by benching in the rock on one side, and embanking on the other with the materials so obtained; beyond this it was cut for a distance of nearly 350 yards through the limestone; in one place to a depth of 41 feet. The sides and bed were there lined with puddle, and protected by a facing of rubble wall. Thence, to the seventh lock, the channel was again formed by benching and embanking through a clay soil, where much caution was necessarily exercised in preventing slips at the foot of the embankment, which was subject to inundations from the Blackwater.

The masonry was all constructed of limestone from an adjacent quarry.

Two Appendices are subjoined to this Paper. The first of these gives in detail the items of expenditure for the portion of the canal described; the second contains a particular description of the locks and lock-gates, the bridges and the earth-work. The locks are 73 feet long, 12 feet wide, and vary in rise from 6 to 11 feet. They are all constructed in ashlar masonry.

The paper is accompanied by three drawings, descriptive of the general plan and the details of these works, which were originally designed by Mr. Telford, and are now under the direction of Mr. Cubitt. They have been executed almost entirely under the superintendence of the author.

An Account of the permanent Way of the Birmingham and Gloucester Railway. *By* G. B. W. Jackson, *Grad. Inst. C. E.*

The object of this Railway is to afford a direct communication between the Western and the Midland Counties of England. The communication describes the course of the line until it reaches Cheltenham, where it joins that which was formerly called the Great Western and Cheltenham Railway, which terminates at Gloucester. Its length is 54 miles. The prevailing inclination is 1 in 300; but on the "Lickey" incline, near Bromsgrove, the rise is 1 in 37 for a distance of 2½ miles, in ascending which the trains are worked by American locomotives, in addition to the usual train engines. The northern portion of the railway appears to lie on the new red sandstone; then passes to the oolitic formation, on which it terminates. In the former, the principal cuttings are through marl, some of which is exceedingly indurated, and troublesome to work. The principal strata of the latter system are blue and yellow clays. Near Cheltenham, the shifting sand frequently rendered sheet-piling necessary in passing through it. The waters of Droitwich and Cheltenham were found to possess a saline quality, which rendered them unfit for the use of the engines; that from the surface sand near Cheltenham, is, however, extremely good.

The building materials employed on this line were—the sandstones of the Lickey and Forest of Dean, the lias of Norton and Wadborough, and the oolites of Cheltenham and Bredon, together with brick, for which earth was readily procured throughout.

The cuttings and embankments, with the details of the permanent way, are severally described. The surface width is 30 feet. In the formation of embankments and cuttings, the usual methods appear to have been adopted. In the former, the slopes vary between 3 and 2¼ to 1; in the latter, between 2 and 1½ to 1.

In cuttings, there is a system of drainage beneath the ballast, consisting of longitudinal drains on either side of the line, connected by cross spits, all of which are filled up with broken stones. The rails are supported by chairs and intermediate saddles, which rest on longitudinal balks; and these are bolted to transverse ties. On embankments, whose height exceeds five feet, the cross spits, longitudinal balks, and saddles, are all dispensed with.

The length of the bearings, the weight, dimensions, &c., of the iron and wood work, with the manner of putting them together, are then noticed.

The timber employed was, American pine, and English beech, or larch. The various prices are enumerated of the materials and labour for the permanent way, of which the average cost per mile amounted to 5,430*l.* The present condition of the line is stated to be good, and its general working to have been perfectly satisfactory, since its opening in June, 1840.

Annexed is a description of an artificial ballast obtained by burning clay, which was employed where the country did not afford natural ballast. Its expense slightly exceeds that of the ordinary ballast; blue clay burnt in kilns was found to answer the purpose best, but it does not appear to form a successful substitute for gravel. The results of experiment show it to form a very imperfect drain. The author states that he has always observed the quality of this ballast to suffer in proportion with the quantity of lime contained in its composition.

The paper is accompanied by four drawings, illustrating the construction of the permanent way.

Description of a Water-pressure Engine at Illsang, in Bavaria. *By* William Lewis Baker, *Grad. Inst. C. E.*

The machine described in this paper is the most perfect among nine engines constructed by M. de Reichenbach, for the salt-works at Illsang, in Bavaria. These important works are situated in the most southern part of the kingdom; they are supplied from a mine in the valley of Berghtesgaden, and the salt-springs at Reichenhall. The salt was procured from the former in two states,—that of rock salt, which was extracted by blasting, and that of brine. The rock salt was conveyed to Reichenhall, and there underwent the purifying process. But both these methods were attended with disadvantages, from the scarcity of fuel; the old method was therefore abolished, and a line of pipes of 7 inches diameter was substituted, which was laid between the two places, a distance of about 60 miles.

A series of water-pressure engines, each working a forcing pump, and

being themselves worked by a head of water, were placed in convenient situations upon the line. The mine is now worked by forming cavities in the beds of salt, and filling them with water, which soon becomes strongly saturated brine; it is then pumped up, and forced through the pipes to Reichenhall, where a portion of it is retained, and the rest is sent on to Frauenstein, which is at the extremity of the line. At these places, the process of evaporation is carried on, and the salt is manufactured in the usual manner.

The paper is illustrated by a drawing of the engine, showing the details of construction alluded to in the communication.

A Memoir of Captain Huddart. By William Cotton, *F.R.S. &c.*

This memoir is intended by the author chiefly to supply some additional facts which are omitted in the account which was published by his son soon after the decease of this distinguished man, whose "great powers of mind, indefatigable industry, and high principles, raised him to a most honourable position among men of science."

Joseph Huddart was born at Allonby, in Cumberland, the 11th January, 1740. His father was a shoemaker and farmer, and had also a small interest in a herring-fishery. Young Huddart was placed under the tuition of Mr. Wilson, the clergyman of the village, and from his son, who had been at Glasgow, he acquired some knowledge of mathematics and astronomy. He early displayed much ingenuity in the construction of models of vessels and of machinery; and while herding his father's cattle, he was occupied in mathematical reading, drawing, and calculations. His determination to adopt a seafaring life was opposed by his friends; and it was not until he was called upon to take his share of the duties on board the herring-fishing boats, that his father was reconciled to his becoming a sailor. At this period, during the hours of rest after his labours, he was engaged in making nautical observations, and laid the foundation for the chart of St. George's Channel, which was published by his friend Mr. Laurie, from his survey, and is still the best chart of that locality.

On the death of his father, in 1762, he took the command of a sloop which was employed in carrying salt herrings to Ireland. He then constructed a brig according to a model of his own, every timber being moulded by his own hands. In this vessel he traded for some years to America; until, in 1771, he was induced by Sir Richard Hotham, (who had discovered and appreciated his judgment and knowledge) to leave the brig and engage in the East India mercantile marine. In this extensive field of usefulness, Huddart evinced the superiority of his talents and his inflexible integrity; and his example as a commander was generally followed. While in the Indian service, his attention was drawn to the defects in the usual manufacture of cordage, and led to the improvements which he afterwards so successfully accomplished.

He subsequently took a prominent part in the direction of affairs at the Trinity House, the Ramsgate Harbour Trust, and the London and East India Docks, where the valuable advice given by him was properly appreciated, as it was also by the civil engineers, with whom he was so frequently called upon to co-operate.

The Memoir then relates many interesting anecdotes of his private life, illustrative of his general scientific acquirements, and of his amiable disposition. It then details, at considerable length, his experiments for the determination of the lines for ships, which, consistent with stability, and what might be required for stowage of cargo, would give the greatest velocity through the water.

The author enters fully into the account of Huddart's inventions and improvements in rope machinery, which he raised to such a pitch of perfection. This machinery, which is now transferred to the Royal Dock Yards, has already been before brought under the notice of the Institution by Mr. Cotton and by Messrs. Dempsey and Birch, in communications, for which prizes were awarded. The general introduction of chain cables rendered this machinery less useful, but could not take from its original merit; and, in its present position, it will long remain a monument of Captain Huddart's perseverance, mechanical skill, and scientific knowledge.

Sir James South thought that Captain Huddart's scientific attainments as an astronomer had not received their due meed of praise in the Memoir; but more especially, that the equatorial instrument, which he was now fortunate enough to have in his possession, should have been alluded to more particularly. That instrument was constructed by Messrs. Luke Howard and Co., of Old-street, from the designs and under the daily superintendence of Huddart. The greatest part of the instrument was put together with his own hands, and the result of this combination of skill and attention was, that up to the present time, the instrument had been unequalled; in fact, he must be permitted to say, that he considered it *perfect*. It had been used for all kinds of observations,—transit, declination, and equatorial; and, in all, with equal satisfaction to the astronomer. With it, Mr. Herschel had made many of his observations, and always expressed himself in the highest terms of it. It had been examined by most of the eminent constructors of instruments, as well as many civil engineers, who all entertained the same opinion of its perfection: and, after a minute inspection, one constructor observed, "Here is the best system of edge-bars and bracing I ever saw, and my opinion of the instrument is, that it is perfect in every part."

Sir James then relates several anecdotes of Huddart's habits of observation. On one occasion, being ordered to sail from Madras at a certain time he delayed his departure, because he observed a sudden fall of nearly three-quarters of an inch in the mercury of the barometer. The result of this disobedience of orders (for which he incurred momentary censure) was, that his vessel alone of all the convoy escaped destruction.

The President believed that Captain Huddart was the first to mark out the direct course to China, which is so generally followed at present. He was also the first observer who took a transit instrument out with him, to determine the rate of the chronometer. It was particularly worthy of notice, that the equatorial instrument and the rope machinery, both of which had been designed by and executed under the directions of a self-educated man, destitute of the means of acquiring instruction either in astronomy or mechanics, had been, up to the present time, unequalled either in conception or in the perfection of their execution. Huddart was the constant coadjutor of civil engineers: he assisted the late Mr. Rennie in many of his surveys of harbours, and on those occasions had always the command of the vessel, even if he did not participate in the actual operations of the survey. Whether Huddart was viewed as a sailor, boldly striking out for himself a new track to his destination; as a ship-builder, constructing a vessel in order to avoid the defects which he observed in the ordinary class of ships; as a hydrographer, displaying in his chart of the St. George's Channel those powers of observation and reasoning which made him an astronomer; as a constructor of the equatorial instrument, which had been so justly commended; or as a mechanic, designing and constructing one of the most beautiful pieces of machinery on record,—he appeared equally great.

The Institution was much indebted to Mr. Cotton for this Memoir of Captain Huddart, whose name would be always venerated by every member of the profession of civil engineering.

Mr. Thornthwaite must in justice correct a misapprehension relative to the laying machine for cables; the idea of that machine originated with the Reverend Edmund Cartwright, who had projected more improvements in cotton machinery than any person, except Arkwright. The machine was materially modified by Captain Huddart, and to him must be given all the credit for the perfection of its proportions, and its careful construction, which had enabled a machine weighing 20 tons, and revolving rapidly upon one vertical spindle, to work a number of years without costing £5 for repairs. The register, which preceded the laying machine several years, was entirely Huddart's invention, and was the origin of his improvements in rope machinery.

Description of the Port of London, and of the Works of the London Docks. By Robert Richardson, *Grad. Inst. C. E.*

In this communication the author examines the state of the Port of London, when the accommodation for landing and bonding foreign produce was almost entirely limited to a single spot, called the "Legal Quay," which was only about 1,400 feet in length, extending downwards from London Bridge, affording no greater facilities for commerce in the beginning of the nineteenth century than in the year 1660, when the quay was appointed. This state of things continued until the year 1773, when Mr. J. Sharpe suggested the formation of floating docks. In the year 1800 the West India Docks were commenced; in the year following the London Docks were projected, and in the year 1805 the East India Docks were commenced. For all these undertakings, Mr. Ralph Walker was appointed engineer, having Mr. William Jessop associated with him for the West India Docks. The paper enters fully into the bad state of the navigation of the river, owing to defective management and other causes; gives a table showing the progressive increase of tonnage and number of ships from the beginning to the close of the last century; mentions the various plans of Dodd, Spence, Reveley, and others, for diverting the channel of the river for the formation of more extensive docks, near the Isle of Dogs; and then proceeds to detail minutely the origin and progress of the London Docks, giving the dimensions and mode of construction of the principal works connecting the Eastern Docks with the Thames, which were constructed under the superintendence of Mr. H. R. Palmer, to whom the author has been indebted for much of the information contained in the paper.

Description of the Ponte della Maddelena, over the River Serchio, near Lucca. *By* Richard Townshend, *Assoc. Inst. C. E.*

The bridge described in this communication, is situated about half-way between the town and the baths of Lucca, in the Grand Duchy of Tuscany; it was built by Castracani, in the year 1317, on the site of one which had been constructed by order of the countess Matilda, early in the twelfth century, and subsequently destroyed; it is believed that a Roman bridge formerly existed on the same spot.

The present bridge is of grey limestone of the country. The large arch of 126 feet 6 inches span, is of a semicircular form, and springs directly from the rocky bed of the river, without any prepared foundation. The smaller arches are of various spans, 46 feet 10 inches, 33 feet, 28 feet, and 7 feet 6 inches. The style of construction is somewhat similar to that of the Pont-y-prydd, over the Taff, in South Wales.

An engraving of the bridge accompanied the paper.

Description of the Mill, Forge, and Furnaces of a Welsh Iron Work. *By* Thomas Girdwood Hardie, *Assoc. Inst. C. E.*

The author commences by describing the general plan of an iron work, consisting of six blast furnaces, four double-fire refineries, and a forge and mill, capable of converting into bar-iron the produce of the six blast furnaces.

He then enters very fully into certain alterations of the interior shape of the blast furnaces introduced by him at the Blaenavon works, from which have resulted an economy of fuel, regularity of work, and an improved quality of iron. The principal alterations appear to be, making the interior diameter greater above that at the boshes, and establishing a proper ratio between the diameter of the boshes and that of the charging place, and proportioning both to the height of the furnace. The opinions are supported by calculations of the quantity of blast used in smelting given quantities of ore, and the effect which the form of the furnaces must have in directing the current of the blast through the materials, by which also the point of fusion would be necessarily affected, and the chemical combinations varied. The particulars are then given of the construction of the furnaces at Blaenavon, and the details of the blowing engines, blast mains, regulators, valves, &c., with calculations of the quantity of blast used in the various processes of the manufacture. The construction of the casting-houses, with the mode of ventilating by the iron roof, is detailed. The general arrangements of the balance pits, coke yards, mine kilns, and bridge houses, are shown, and the author proceeds to describe the forge and mill, which have 35 puddling furnaces, with hammers, shears, rolls, and heating furnaces in proportion. He then condemns the usual practice of leaving the coupling Boxes loose upon the spindles, as liable to break the rolls, shafts, or machinery, and gives the theoretical and practical reasonings for preferring fixed couplings.

The communication is illustrated by three drawings, showing the general distribution and the details of an iron work.

Mr. Lowe believed that there was an incorrectness in the statement, of the iron after being freed from its oxygen by the heat of the furnace, taking up a dose of carbon from the coke, thus becoming a carburet of iron, which is a fusible compound, and as such, fell melted into the hearth. On the contrary, he thought that the iron was combined with carbon in the ore, and that there was not any necessity for the medium of the fuel to charge it with carbon.

In reply to "Why the ore required, or why the iron carried away, any of the carbon of the fuel?" Dr. Faraday stated, that the ore being essentially a carbonate of iron, the first action of heat, either in the mine kilns or in the furnace, was to draw off the carbonic acid and leave an oxide of iron, and then the further action of the fuel (besides sustaining a high temperature) was to abstract the oxygen of the oxide, and so to reduce the iron to the metallic state, after which a still further portion of the carbon of the fuel combined with the iron, bringing it into the state of easily fusible or pig-iron.

As carbon may be communicated to the iron in two ways, distinct in their nature, either by contact with solid carbon, as in the process of cementation (that by which steel is commonly converted), or from the carbonated gases, either carburetted hydrogen, or carbonic acid, which occupy nearly every part of the air-way of the furnace, it would be desirable to distinguish, as far as may be in any furnace having a particular form or action, what proportion of the whole effect is due to the one mode of carbonization or the other.

Mr. Wallace stated that the ore was a carbonate of iron, or a protoxide of iron and carbonic acid united, and not a carburet of iron (or iron and carbon simply), as was generally believed. In smelting, the carbonic acid was driven off, the simple oxide remaining; the oxygen of which, being carried off by the heat, left the pure iron, which combining with the carbon of the coke, formed a fusible carburet of iron, or the pig-iron of commerce.

Mr. John Taylor observed that his brother, Mr. Philip Taylor, being sensible of the advantages to be expected from the use of anthracite in smelting iron, made a series of experiments several years ago, from which he derived the opinion that the carbon absorbed by the metal, and which is necessary to produce it in the shape of pig-iron, must be presented in a gaseous state to the mass in fusion; and as anthracite did not afford a sufficient supply of coal-gas during combustion to produce the proper effect, he proposed to adopt a very ingenious method, by which this gas would have been thrown into the furnace in such proportions as might be found necessary, mixed with the common air employed as the blast.

Circumstances interrupted the course of these experiments, or it is possible that the use of anthracite for this important application might have taken place at a much earlier period than it has happened to do.

AGRICULTURAL IMPROVEMENTS.

The increase of the quantity of corn and other productions of the land is the most important subject that can occupy the British agriculturist; because, from careful study of all the data, we are convinced that a fourth, or even nearly a half, more both of corn and of cattle may be grown and fed in the country than is the case now.

Mr. J. B. Denton, of 9, Gray's Inn Square, an intelligent surveyor, has recently published a very able pamphlet, in which his main attention is to call the attention of parliament, or rather of the committee now sitting, to the subject. Mr. Denton's pamphlet consists of two principal points: the economy of water, and the conservation of manure. In the first of these he treats of other uses of water after it has done its work in an agricultural point of view; and in the second he contends for the conservation of the manure of towns, as a most important commodity, which is now, in a great measure, and threatens to be still further, taken from the agriculturist. Mr. Denton writes clearly and well, and with perfect knowledge of his subject; his pamphlet is, however, too brief and full of matter for abridgment; and, therefore, we quote the annexed passage as one in which the public generally have a deep interest, but which, to the majority of them, is unknown. We do this the more readily that the plan, if acted on, would give great and useful employment to engineers.

Water is far more under the control of the cultivator, and it may justly be said that the proper distribution of it is the first step in efficient agricultural improvement. The object is not to increase or diminish the total quantity of water, for that is beyond the power of man, but so to regulate its distribution with regard to surfaces and seasons, as that it may be in the most wholesome state, and co-operate with other natural and artificial causes in producing the most healthy, vigorous, and profitable vegetation, both on tillage lands and pasture.

In order to do this most cheaply and successfully, the cultivator must understand something of the nature and working of water; because, unless he does this, it is impossible for him to turn it to proper account. He must also know something of the air or atmosphere, and its uses in the distribution and working of water. It performs other and very important services in the growth of vegetables; but it performs these simply as air; and, therefore, there is no need of farther allusion to them in treating of water, its distribution and effects.

As no species of plant cultivated in Britain for human food, or for that of domesticated animals, vegetates in stagnant water, the cultivator can derive no benefit from it, but rather the reverse, unless where it is accumulated or stored up in tanks or ponds to serve some useful purpose, such as that of collecting a fertilizing sediment, or for use as a power in turning machinery, or performing some other labour. Living water, or water in a state of motion, is what is required for the production of useful vegetables; and, wherever this is not supplied naturally, art must be called

in to assist. Stagnant water is always injurious, whether it stagnates on the surface, or in the soil or subsoil; and, therefore, the portion of it which is requisite must be put into motion and action, and the surplus removed by drainage, and, if circumstances will admit, conducted to other places where it may be useful. The distribution of living water over the surface of the ground is what is termed irrigation, and in Britain it is applied and applicable only to grass lands, either for hay or for pasture, though in warmer countries rice and some other plants which are grown for food require to be even more copiously supplied with surface water than our irrigated grass. The removal of surplus and stagnant water is drainage; and it may be surface drainage by open furrows or channels, under-ploughing or loosening the subsoil, or drainage, properly so called, by water-courses formed below ground, and covered up so that the surface of them may be cultivated and cropped the same as the rest of the fields in which they are situated.

The first circumstance necessary to be known in order to the right performance of these operations is, the quantity of water, and the way it is naturally distributed. Besides what appears on the surface, in streams, ponds, and lakes, and what falls upon that surface, there is always a considerable quantity in the atmosphere. This quantity is of great service to the parts of plants which are above ground, refreshing them at all times, and often serving as a substitute for rain during pretty long periods.

Water is not understood to be generated or produced in the atmosphere, but to be raised from the surface of the waters, the moist land, growing vegetables, and other substances having humid surfaces, by the process of evaporation, that is, by the dispersion of water through the air in an invisible form. The quantity of evaporation, or vapour raised, depends on various circumstances. It increases as the atmosphere becomes warmer, as it is rarer, and as it is more in motion; and the production of vapour is always a cause of cold, because vapour is water separated into small portions by the action of heat. There is no chemical or other principle of combination between the air and vapour; they are simply mixed, and the water rises in vapour by the stimulus of heat or the removal of pressure, and probably by some electric agency with which we are unacquainted. As it is merely mixed with the atmosphere, it is separable by the slightest effort of the feeblest thing in nature, whether animal, vegetable, or mineral, and thus its agency is obtained at the least possible waste of any thing else.

All the water which the atmosphere contains, and all which it returns back again to the earth in rain or any other form, is previously sent up to it by evaporation. The quantity thus evaporated is greater than that which falls in showers, because there are other means by which it is again separated; the chief of these are, simple absorption by growing vegetables, and the formation of dews and ground mists, when the surface of the ground and the air immediately in contact with it become cooler than the air higher up. This quantity, which, however, owing to the currents of the air, is never twice identically the same at the same place, varies with the latitude, the seasons, and the character of the country; and there are also variations between one year and another, which are accounted among the uncertainties of the weather, some of the causes of which are known, and some are not. The greater portion of water which thus works between the air and the earth, and the more equally it is distributed, the more favourable the country for vegetation. Hence, a district which has the greater part of its surface covered with vigorous tillage-crops, or grass, during the season of growing, is the most favourable to the growth of every vegetable; and if we suppose two fields alike in all other circumstances, but the one of them in a rich champaign country, where all around is thriving crops, irrigated meadows, and healthy and well-covered pastures, while the other is surrounded by morasses, or by dry and bare wastes, the crops upon the latter will be miserable in proportion to those upon the former. This is a strong argument in favour of irrigation, and of the drainage of grass lands, in as far as that contributes to the abundance and kindliness of the vegetation; for such lands nourish the tillage-crops, whereas barren grounds injure them to a much greater extent than many would suppose.

A close vegetation in a vigorously growing state is, also, advantageous in preventing floods or lessening their amount, and thus, when there are crops upon the gronnd, we have not the same flooding from an equal depth of rain, as when the crops are removed, and the fields comparatively bare. In a country so diversified with hill and dale as Britain, the prevention of floods is a very important matter, for the rain and wind, beating on the naked surface of the ground, wash the finer particles into the hollows, in which it produces a retentive soil, favourable to the growth of mosses, or is carried seaward by the floods, forming banks in the estuaries, and injuring the navigation of the rivers. Besides, these banks impede the outfalls, and increase the inundations and damage done by them. A remarkable instance of flooding occurred in the hollows to the southward of Salisbury Plain, in winter, 1840-1841. The ground was frozen, with some snow over it, and heavy rains set in, which soon melted the snow, and then the whole descended, till several of the hollows were covered with a rolling flood to the depth of fifteen or sixteen feet, by which the cottages were destroyed, and the crops sown in autumn washed out of the ground. In last autumn there was a good deal of flooding and consequent destruction, and the floods rose first and highest where the uplands were most bare. These casualties cannot be altogether prevented, but they might be greatly diminished by a richer surface, and also by catch drains and tanks, whereby much of the water, as well as the rich alluvial matter with which flood water is always impregnated, might be preserved for enriching the soil, and also as a power.

The absolute quantity of water which rises in vapour and descends in rain in the course of the year, is not of so much importance as the time and manner of the falling. If the fall be in occasional showers, unless these occur at very improper seasons, it is more nourishing and less destructive than when it is collected into a single rainy season, occurring when the ground is most bare of vegetation. Proximity to the sea, and diversity of surface, give Britain the advantage of many countries in this respect, both in its tillage ground and its pasture, because the circumstances noted give a pretty equal distribution of humidity both in place and in time. It is true that more rain falls on the elevated and colder lands, and that most rain falls in the winter season, but these facts are both favourable for adapting the water to irrigation, inasmuch as irrigation does most good to the land, if performed after the corn crops are carried, and is a protection against frost; while the higher the source, the greater the power of the water.

In estimating numerically, in any known measures, the average quantity of water which rises from the earth in vapour, descends upon it in rain, or exists in the atmosphere, there are imperfections in the data, and other difficulties, which reduce the conclusions to mere approximations; and even as such they are far from satisfactory, though, so far as observation and experience have gone, there is some agreement between them and the theories.

According to the calculations, the average quantity of water suspended in the atmosphere, if it were all precipitated to the surface of the land and sea, would amount to four inches in depth, or 11,794 cubic miles of water. This is greatest at the Equator, being about 8½ inches, while at the Poles, it is only about 1½; in the average latitude of Britain, it is about 2½ inches. The quantity of rain which falls would follow the same law, if it were not that different surfaces do not equally supply the same evaporating power. The average annual depth of rain for Britain, according to the experiments of Dr. Dalton and others, may be taken at 30 inches. This supplies all the springs, and all the water which works on the surface of the earth, including streams and rivers, and their floods; and the quantity discharged annually into the sea, is estimated at about 13 inches depth in the year, but here it will be no great error if, for the sake of simplifying the calculation, it is taken at 12 inches, or four-tenths of the average fall of rain. The surface of the British islands, in round numbers as already hinted, is 77,000,000 acres, and at the average given, it would be easy to calculate the quantity of water which falls upon it during any given time. If, however, the power of this water is sought, a smaller but indefinite breadth of land must be taken, because there are some places which discharge no water, and others where it cannot be rendered available as a power. Say that the total breadth in all the lands in Britain from which it is available is 50,000,000 of acres, and that for England and Wales 20,000,000; and, making allowance for waste, one foot in depth of water over each of these is a power, whether it can be turned to account or no.

The first gives 2,178,000,000,000 cubic feet of water, and the second, 871,200,000,000 cubic feet.

To reduce these, or either of them, into horse power, there is this datum, according to the ordinary estimates: about 37½, say 38 cubic feet of water, falling every minute on an overshot wheel of 10 feet diameter, is reckoned the power of one horse. Divide each of these numbers by 525,960, the minutes in a year, and the first is the cubic feet for all Britain in each minute, and the second the same for England and Wales. Divide, again, by 38, and the results are the horse power, that for the whole islands being a constant power of 108,973, and that for England 43,590. This, however, supposes the water power to be only on a ten-feet wheel, and that wheel to be in motion every minute of the year.

But in no one instance will such be the case. 12 hours in the day will be the utmost length of working, and ½ of the year will suffice for ordinary farm work, and this gives 12 times the above number, or 523,080 horse power. But this is supposing only a single ten feet fall; and every additional ten feet doubles the power. Say that the average of falls one with another in England and Wales is 50 feet, and the total horse power working, as above stated, will be upwards of 2,000,000. This is for the surface water alone; and if the floods were conserved in tanks and reser-

voirs, judiciously placed, and of proper size, this power would be increased, and a great saving of alluvial matter effected; but there are no satisfactory data for calculating the amount.

Then, for the water which will be obtained by general drainage over and above the quantity which escapes from the lands, there are absolutely no data whatever, for that must depend on the breadth of land which is drained, and the quantity of water afforded by the subsoil springs. It has been calculated that, where the land before draining is very moist, the drainage water will irrigate, in a proper manner, one-fifth as much water meadow as the land drained. But this is too much for the average of England, and we must not allow more than one-eighth, and perhaps one-tenth would be nearer the truth.

The usual estimate is, that 10,000,000 of the 12,000,000 acres of arable land in England and Wales require drainage; and in order to carry the system of irrigation as far up the hills as possible, 10,000,000 more out of the residue, and which require draining, would be added to that amount. All this could not be done in a year, or probably in a century; but it is a result which could be aimed at, and therefore it may be kept in view. Water sufficient to irrigate about 20 acres would, on a wheel 20 feet in diameter, give one horse power; and if we divide by this, the 2,000,000 acres, irrigated by the drain water of 20,000,000 acres, it would give us a power of 100,000 horse power, upon a single fall of 20 feet. But when tanks and reservoirs are used, the last, if there are more than one, should be made to answer as mill-ponds. During heavy rains, this would retain the flood water and the substances with which it was charged, and thus conserving both the fertilizing and the mechanical power in those places where they might be most advantageously applied.

What have been stated, are only approximations; but the principles are sound, and it may be of advantage to those who wish to study the subject, and profit by studying it, to have the outline of all its advantages before them. The next inquiry will be into the nature of the substances by which water should be impregnated for irrigation, and also the increase of manures for cultivated land that might be obtained by preserving the sewerage and refuse of towns.

Water, when in motion, whether in the atmosphere or on the surface of the earth, always refreshes plants when applied to them in moderate quantities; and excess, both in quantity and in time of application, rots them, or is otherwise deleterious, though not so much so as stagnant water. But water of itself does not enrich the soil and render it more fertile, neither has it any tendency to remove a coarse and profitless vegetation, and replace it by a better. Thus, a piece of ground covered with rushes, with sedges, with bents, with mosses, or any other coarse vegetation which is unprofitable for animals, may be irrigated for any length of time, and any of these vegetables may be rendered more vigorous by this operation, but not one of them will thereby be exchanged for a more valuable species. Water, to produce the proper effect, must hold in solution fertilizing ingredients that will enrich the soil, and the irrigated surface must be rendered favourable for the kind of plant that is wished to be grown. This last object may be partially obtained by working the land when it is dry; but the best means is by Under-drainage.

The enriching matters with which water should be loaded for successful irrigation, are the fine alluvial particles brought down from the higher grounds by natural streams or artificial water-courses, and manure brought in like manner from manured lands, from the liquid materials of the farm yard, or from any source whence manure can be obtained, and made to flow over the surface along with the water. Whatever the substance mixed with the water is, the vegetation retains it on the irrigated surface; and it must be very rich before it can be applied to ploughed land, or to places not covered by vegetation: the simplest ingredient is alluvium, washed from lands not under the plough; but the soil of a hill, brought by water into low grounds, and there applied for irrigation, is favourable for the delicate grasses which form the finest pasture, though it does not stimulate such heavy crops of hay as richer irrigation.

British cultivators seldom seek for anything more rich than these washings of the higher ground, though, in the cases in which more stimulating substances have been applied, the advantage has been very great. They also neglect, and allow to go to waste, many substances which would be most beneficial to ploughed land, as well as others which are better suited for irrigation; and both kinds of which are preserved and prepared very carefully by foreigners. This omission on the part of the British cultivator, is owing to the comparative abundance of farm-yard manure which is ready at hand for carting on to their lands; and foreigners endeavour to make up for their deficiency in this respect, by preparing manures which are quite unknown to the British farmer, or are unheeded by him. The chief of these are human manure, and the liquid manure of animals; and if these were duly taken care of, they would add much to the fertilizing stimuli in use among our cultivators. In China and Japan, and other parts of Eastern Asia, where the manure-producing animals are remarkably few, human manure is preserved, collected, and prepared with the utmost attention; and in many parts of the Continent, more especially in a zone or district extending from the Swiss mountains to the shore of the North Sea, the same substance, and also the liquid manure of animals, are very much used as top dressings, both for the pastures and the tillage lands.

In Eastern Asia, the human manure is kneaded with clay, formed in tablets, and baked and dried in the sun, in which state it loses its offensive odour, but retains most of its fertilizing qualities. These tablets are chiefly prepared in the neighbourhood of the cities, towns, and more populous villages, and, under the name of *Taffoo* they form an important article of inland trade. In Paris, Berlin, Munich, and some other large towns on the continent, a manure pretty similar in substance is prepared, only it is powdered, after being dried, and is known in France by the name of *poudrette*.

In England, no such substance is ever prepared; but the refuse of the towns is washed away and lost. According to Dr. Sprengel, the Professor of Agriculture in Brunswick, 1200 lbs. weight of human excrements is reckoned for each unit of population, while Liebeg and Boussingault calculate 547 lbs. as the yearly amount. Now these are widely different, and show the discrepancy of the statistical data afforded us upon the matter; still we may deduce from the two some means by which to gain an approximate amount of the total value of the human manure in the country.

Let us take a medium of 800 lbs., which will give us 12 thousand millions of pounds yearly, as the produce of England and Wales: this, reduced to tons, will give above 5 millions, which is capable of obtaining the richest possible crop from an area of 1,500,000 acres. I mention this only to show the amount of valuable matter which is lost, for I am not so sanguine as to believe that, to its full extent, this amount can ever be applied, but refer you to my previous statement, in which I computed the amount of refuse of those towns which under the proposed measure for the sewerage of towns might, by judicious organization, be conserved and really rendered available.

This, as I before stated, is the reason why it is so important to have a general drainage, irrigation, and manure-conserving Bill passed along with, or reciprocally agreeing to, the Drainage of Towns Bill, for the introduction of which Her Majesty's government stand pledged. This solid part of the manure suited for lands to be ploughed, would form only part of the advantage, as much might be derived from irrigation by their liquid mixed with water, in situations where it could be applied. Some notices of the effects of this will be given afterwards. In passing, however, we may remark, that the blood of animals is among the most powerful of all manures; and thus, if the animals were slaughtered in abattoirs, and the whole cleanings conveyed to reservoirs, a very considerable addition of excellent manure might be obtained.

In the case of stall-feeding, and farm-yard keep, it is estimated that each head of cattle so kept all the year round, will afford manure for an acre; and a horse which is much in the stable will not furnish a great deal less. There are no data from which to obtain the amount of cattle stall-fed, or kept in the farm-yard, or for the number and time at pasture in the fields; and the same want applies to the in-door and out-door keep of horses; but if we take them altogether, adding such composts and caustic manures as are often used, together with crushed bones, bone dust, and various kinds of refuse obtained from those who use animal substances in their manufactures, there is, exclusive of the quantity that might be obtained from towns, abundance for manuring and top-dressing the whole of the arable land once in three years, which is sufficient to keep it in perfect good heart, under the most scourging rotation; and thus, allowing the farm-yard manure to be sufficient to keep the present arable land in good heart, the refuse of the towns would be adequate to the bringing one million of acres under the plough, and treating it as liberally as the present tillage land is treated. That all the effect of every kind of manure may be turned to the production of the best crops, we should always remember that it is necessary that the land should, in the first instance, be well prepared by drainage, for, if this is not done, the benefit of all manures will be lessened, while in some cases there will be no benefit at all.

THAMES EMBANKMENT.

The following is an abstract of the voluminous report of Mr. Walker, the President of the Institution of Civil Engineers, on this subject, which contains a vast deal of interesting matter.

After stating the object of the survey, which has been more extensive than any before undertaken, Mr. Walker enters into a consecutive detail of the measures adopted for the removal of the evils existing in the river, and refers to the evidence which he gave before the House of Commons committee on embanking the river between Vauxhall and London bridges, a measure far less extensive than the object of investigation now on foot, which embraces the whole length within the jurisdiction of the Lord Mayor, from Staines nearly to the mouth of the Thames, a distance of upwards of 75 miles, with London near the middle of it.

"The subject is," Mr. Walker says, "very important, whether considered in reference to the commerce and shipping of London, with its extensive docks, and the country round and above it, or as the quiet drain of a very extensive district, calculated at about 6,000 square miles, including the first city in the world, and therefore affecting the health, wealth, and comfort of millions of human beings. Without going into difficult questions as to the changes which may have taken place in the direction of the main stream of the river, it is evident that great labour and skill have been applied to confine it within its present banks, which from London to the mouth of the river, a length of 40 miles, are chiefly artificial. The probability is, that gradually as the embankments were raised, the ground at the back of them became higher by the deposit consequent upon the diminished action of the waves upon it, and that the creeks and irregularities filled up; notwithstanding which the marshes are still from 6 to 7 feet under the level of an average spring tide, and 9 or 10 feet under the highest tides. One of these tides, that of the 18th of October, 1841, the highest recorded during at least half a century, rose 3 feet 6 inches above the Trinity standard of average spring tides marked upon all the bridges, and was 10 feet above the level of the low marshes; so that if the artificial embankments were cut through, the Thames would at the very next tide take possession of the large space which has been so long abstracted from it, and would be generally five times its present width. The last calamity of the kind that occurred took place at Dagenham, nearly 140 years since, the stopping of which, by Captain Perry, was probably the most important work done in the Thames in the course of that century. Since I have been engineer (30 years) to the Commissioners of Sewers no breach of any consequence has taken place."

After ascribing the present embankments, which he says are the result of skill and bold enterprise not unworthy of any period, to the ancient Britons under Roman superintendence, and giving an account of the tides, Mr. Walker says—

"But, although the artificial embankments have not produced much effect upon the positive height of the surface of the water at either high or low water, they have by contracting the width undoubtedly done much to increase the depth under low water of the part between the banks, and thereby to improve the river for an extent of navigation for which in its natural state it would probably have been quite unfit from the want of depth, and from the uncertainty of the channel. This deepening has been effected by confining the current downwards of the land or fresh water united with the tidal water to act upon a limited width, instead of being diffused and its force spent over a great surface; thus its velocity and scouring force have been increased, and the channel has been deepened. . . . . .

"As respects the fitness of the Thames for trade, we have, with the exception of some shoals, a depth of from 12 to 14 feet at low water, nearly up to London-bridge; and a width nowhere of less than 700 feet; but generally 1,000 feet at high water near London, a distance of 40 miles from its mouth.

"As respects its salubrity, it is to be observed, that in addition to the river or fresh water, which even as high as Staines, 37 miles above London, flows at the rate of 150,000 cubic feet per minute, and is much increased by the streams which afterwards join it, and still more by the springs which rise up under it in its course downwards, there is also the very much greater volume of tidal water rising and falling in every 12 hours from 14 to 19 feet in vertical height, in constant motion, at a speed of 2 to 3 miles per hour, carrying past London upwards of 70,000 tons, or from 2,500,000 to 3000,000 of cubic feet of water in every minute of time. Even the defects which are at present apparent, and so much require removal, arise in a great measure from the altered state of things at the end of perhaps 15 centuries from that time when the Thames was embanked, rather than from the ignorance of the engineers who at that distant period had the direction of this great work."

Mr. Walker next proceeds to speak of old London-bridge.—"It is to be noticed also that the clumsy erection of London-bridge in the 12th century much disturbed the uniformity of the river, as left by the original embankers. Its 18 piers with starlings, each from 30 to 50 feet in thickness, reduced the width of the waterway from 920 down to 300 feet, and the sectional area in nearly the same ratio; and this small waterway was further interrupted by nine of the openings having the wheels of the London-bridge water-works before them. These erections, increased by the stone that was from time to time thrown in the openings and round the piers, to prevent their being undermined and the bridge being carried away, acted as a solid weir or dam in diminishing the scour of the river, and causing an accumulation of matter above the bridge. Hence not only the high-water difference to which I have referred, but also the difference at low-water; for when the tide was out, the water above the bridge was prevented ebbing so low as it did below the bridge by from 3 to 5 feet; whereby the quantity and strength of the tidal current were lessened, and the solid bed or channel of the river above the bridge was raised from 8 to 10 feet higher than below it. This great evil is now removed. The present fabric has a waterway of 690 feet in width, with a great increase of depth under the arches; the whole channel of the river above bridge has since, from the increased current, been gradually lowering. Hence already has it been found requisite to support by piling round (within coffer-dams formed at great expense) the piers of Blackfriars-bridge; and the like operation is now in progress at Westminster-bridge, of which the waterway is 820 feet."

Mr. Walker then goes into a variety of particulars respecting the present authorities and management, and after stating that he is not aware of any navigation improvement fund that could be made available in removing shoals, or narrowing or straightening the river, proceeds thus:—"I am sure, at least, that very little indeed has been done in this way; and it is not, therefore, surprising that from the alterations occurring in so great a lapse of time there should be many things requiring attention and improvement. To state these, and the manner of effecting them, is the matter now to be considered." Mr. Leach's report states the defects and desiderata from Battersea-bridge upwards, and the obstructions caused by the awkward positions of the bridge, and the small opening between the piles or piers. These bridges are, indeed, altogether unworthy as respects utility and appearance of the situations, so near London, which they occupy. The following suggestions are directed chiefly to the part from Chelsea-bridge downwards:—

"The greatest defect in the river is the irregularity in its present width and depth, and in the line of the wharfs and banks that form its sides. As examples—the width half a mile below Fulham-bridge is 820 feet. Two miles lower, or half a mile below Battersea-bridge, it is 745 feet. One mile lower, opposite the Chelsea waterworks, 1,000 feet; one mile and a quarter lower, opposite the Penitentiary, only 600 feet; three quarters of a mile lower, opposite the houses of Parliament, before the new river wall was built, it was 1030 feet, and now is 924; half a mile lower, opposite Hungerford market, 1,450 feet, which is nearly two and a half times the width opposite the Penitentiary; three quarters of a mile lower, below Blackfriars-bridge, 995 feet; three quarters of a mile lower, below Southwark-bridge, it is contracted to 720 feet, just half the width opposite Hungerford market, which is one mile and a half higher. The irregularity is less below London-bridge, with the exception of the contraction to 770 feet, opposite Limehouse-bridge dock, three miles below London-bridge, so that the great inequalities are chiefly in the wharfed part at London.

"Now, on reference to the plans, and the table of widths and observations appended to this report, it will be seen, generally that where the river is narrow there it is deep, and comparatively clear of mud, excepting where the bends divert the strength of the tide to one side; but where the width is great there are shallows and muddy banks, which are injurious to navigation and to health. A main object, therefore, is to take means for removing these evils by approximation to an uniform width and depth, and with the exception of the cases where the shore between high and low water is used for coal-barges and floating timber, it is generally the interest of the owners of the particular property, as well as of the public, that they should be removed."

Mr. Walker here points out the want of system or plan for guiding the lines of wharfs or embankments, and refers to the accompanying plans as calculated to remedy the defect. He says, with regard to this great object, "It is impossible to do a great good without producing a small evil, or at any rate without raising an objection; but I have no hesitation in saying, that whether compulsory or voluntary, the uniform new embankment and deepening would be a great public and generally a private benefit. It would be discreditable that the irregularities in the present bottom of the river above London-bridge should be suffered to remain, when the immense importance of the navigation is considered. These irregularities have increased, as well as become more apparent, since the removal of old London-bridge, which has lowered the water above and near the bridge four or five feet, the effect lessening as the distance increases, that at Westminster-bridge being from two to three feet."

On the subject of the various schemes of terrace roads, railroads, &c., which have been proposed upon the bank of the river between Westmin-

ster and the city, Mr. Walker says—"As regards the embanking of the river, it might be sufficient to say, that the recommended line does not interfere to prevent the formation of any of the terrace or road schemes which are proposed; but as our attention has been drawn to the road improvements upon the banks of the river above Vauxhall-bridge, it would be improper not to refer to this as a result of the projected embankments, which Mr. Cubitt will probably be the first to carry into effect, on an enlarged scale, upon the estates of the Crown and the Marquis of Westminster. So far as we have been able to judge, from the opinions of those most largely interested, there appears a probability that a carriage-way will be formed along the bank of the river from Chelsea nearly to the new houses of Parliament. The east side of Milbank-street is the first interruption. If upon the site of the worst part of Westminster, the property of the Dean and Chapter, or upon the vacant Crown land round the Penitentiary, a basin or dock were formed, with an entrance near the Horseferry, for the trade of the present Milbank-street wharfs, the houses in that street, which are of value chiefly as connected with the wharfs, might be taken down, and the site of them, with the embanked ground of the river, applied to form a terrace attached to the houses of Parliament; the view of the river from the drive would be uninterrupted from Chelsea until reaching the houses of Parlament, where the road would necessarily leave the water-side for Palace-yard, Parliament-street, and Whitehall; it might then turn down Whitehall-place or Scotland-yard, whence it could be carried upon arches springing from piers in the new embanked ground, down to Blackfriars-bridge, and thence by a direct street to St. Paul's and the Royal Exchange, or might fall into some of the new and improved streets in progress, or projected by the city authorities. A splendid communication would thus be formed from Chelsea, or from above it, along the river into the heart of the city. It may be some time before all this can be accomplished; but it would be easy to show that from Chelsea to Milbank, and from Milbank to Blackfriars, it would not be a very difficult or expensive work, that it would not interrupt the trade of the wharfs between Whitehall and Blackfriars, and that the proposed line of embankment would be in furtherance of this object."

Mr. Walker, after at some length showing how the sewers would be improved by the proposed embankment and contraction of the width of the river, particularizes the shoals below London-bridge, and goes on to say, "I find by calculation that about £60,000 would remove all these shoals from the line of navigation, and make a passage 12 feet deep at low water, were none of the materials suitable for ballast. The sum does not appear large, compared with the almost national object. The Birmingham Canal Company are laying out nearly four times the amount in a new canal 8 miles in length, fitted for the trade of narrow canal boats only, and intended, not for a new trade, or a new source of revenue, but to shorten the route for the present trade, chiefly of coals and iron, from the mines to Birmingham. A very small rate, say one-eighth of a penny per ton, upon the trade, would effect it. The amount of tonnage which paid light dues on passing the Nore inwards in 1840 was 4,406,000 tons. My estimate for the still further improvement of the Clyde, for which an act was passed in 1840, was £800,000. Ought then the immense trade of the Thames to remain any longer impeded, and the vessels navigating it to continue any longer liable to delay and damage, if the cause of such impediment, delay, and damage can be removed for anything like the sum I have named!"

The following are the concluding paragraphs of the report:—"I have appended a table showing at various points the present and proposed width of the river, with the contraction on each side. It is not necessary for the public objects I have stated that every part should be embanked. To some it may be inconvenient in various ways; but if the unembanked part, or the dock, became private property, to be used only by the owner of the premises behind it, its value to him may thus be increased, and he might thus have the option of wharfing in the line of the adjoining quays whenever he might wish to do so. The effect of every erection between high and low water is to decrease the quantity of tidal or backwater upon which the depths below those embankments mainly depend, and the embankments we are recommending for narrowing the river are of this character; but as the material for filling behind the embankments is to be taken from the bottom of the river, the effect of this will be to let the water ebb out lower, and thus to increase the space for the return of the flood and the backwater. I find by calculation that the lowering of the surface of the water above bridge one foot vertically for four miles in length, will equal in cubic quantity the whole solid contents of the embankments above London-bridge.

"In the time of heavy rains the low lands up the river are liable to be flooded. The effect of the narrowing by embankments will be to increase to a small extent the obstruction to the descending floods at the first of the ebb; but this will be much more than compensated for by the additional depth which operates through the whole period of the ebb; so that the general measure will, as respects the drainage of the country, be a decided advantage.

"Whatever wharfing is done in the proposed line should be done securely; and in case of failure a ready means of rebuilding, or, at least, of preventing a nuisance, is essential, whether it be a dry bank or a wharf wall. The public ought to be protected against damage by the owners of property abutting upon the river; and if the owner neglect to do this, there is, I apprehend, or surely there ought to be, a power to compel him, as well as a summary way of abating the evil.

"I am afraid that in some points referred to in this report I may have gone too much into detail, may have been in others too general, and may have entirely omitted matters of greater moment than those I have remarked on, but surely enough has been thought and said to show the great, the almost national importance of the subject, and the capability of adding essentially, at comparatively little expense or trouble, to the commercial and general utility, and to the ornament of this splendid river, for the navigation of which so little has been done during many centuries, and to the making of it still more instrumental to the comfort and health of the inhabitants, as well as contributing to the extent, beauty, and value of the property upon its banks."

MISCELLANEOUS.

STANDARD MEASURES.—It is said that the standard measnres were destroyed in the late conflagration of the Houses of Parliament. The contents of the Winchester bushel depended upon whether it was derived from the standard pint, quart, gallon, or bushel, each giving a different result. The imperial bushel of 32 quarts is precisely equal to 33 quarts of the Winchester measure. It is curious enough, that those to whom the adjustment of the measures of capacity has been confided should still hold fast to such a perplexity of fractions; for instance, the contents of an imperial quart are 69 cubic inches and 318 parts in 1,000; a peck, 554 cubic inches and 548 parts in 1,000; a bushel, 2,218 cubic inches and 192 parts in 1,000. It is very strange that the cubical measure should not have been adopted, whereby a quart of 4 inches cube contains 64 inches, a peck of 8 inches cube contains 512 cubic inches, and a bushel of 16 inches square and 8 inches deep, being half a cube of 16 inches, contains 2,048 cubic inches, without any fractions, and a bushel of wheat, of these dimensions, should weigh 60 lb. The manner of reducing the cubic measure to the cylindrical has been fully set forth in a pamphlet on the subject. It is understood, that the standard measures are to be restored under the superintendence of three scientific gentlemen, who are inclined to introduce the decimal system, which, if applied to money, would be as easy a matter as it would be to adopt the octonary division; but nothing can be better than the present division of weights and measures. It is only required to simplify the sub-divisions by avoiding fractions, which might be completely effected by making cubical measures the standards or tests of quantities, and then every poor person might readily ascertain whether he was fairly dealt by or not.

THE DEAD SEA.—Lieut. Symonds, R.E., son of the distinguished naval architect, has lately triangulated the country between the Dead Sea and the Mediterranean, and finds the latter extraordinary basin to be 1,337 feet below the level of the Mediterranean. Former measurements, by incorrect and uncertain methods, such as the boiling point of water, &c., gave the depression at only 500 or 600 feet. Lieut. Symonds proceeded from level to level by two different routes, nnd the results of each differ only by an insignificant fraction. By the same process, the lake of Gennesareth turns out to be 84 feet below the level of the Mediterranean: taking, therefore, the valley of the Jordan at 70 miles long, the mean depression of the soil must be nearly 18 feet per mile, quite sufficient to account for the rapidity of the Jordan, which preserves its course almost due south with very little winding.

RAILWAY IN GERMANY.—The Government of Wurtemberg has resolved to run railroads along the most frequented valleys of that mountainous country, thus uniting the Neckar and the Rhine with the Danube and the Lake of Constance; and a loan of 2,300,000 florins is announced for this purpose. This is the fifth grand railroad system announced to be commenced in the present year (three centre in Berlin), in various states of Germany. From a survey given in the *Augsburgh Gazette*, of the operation of the railways now existing, it appears that about 5,000,000 passengers were last year transported various distances at the rate of at least 15 miles per hour, upon 16 lines. On three of the shortest lines, the

number is the greatest. The line from Vienna to Neustadt had 831,990 passengers. The distance is three posts, or about 30 miles, but the majority of the passengers went only to and from Baden, or about 15 miles. The Berlin and Potsdam line had 577,620, and that from Magdeburgh to Leipsic 511,654 passengers. The Taunus line had 765,975 passengers, and the short line from Nuremburgh to Furth, a distance of about four miles, the first attempt that was made on the continent, and on which horse-power alternates with steam, had 448,854 passengers. The two last named lines are those which pay best, as the passport regulations interfere least with them, and the expenses on short distances are the lightest. As our neighbours were so long accustomed to more sedate and less exciting modes of conveyance, this change may be expected to form an epoch in the national development of no small importance. The precision and security which railroads give to all combinations which time and distance usually render uncertain, or even impossible, must be doubly perceptible in a country in which the population is scattered over so wide an area. It is certainly sound policy in the Governments to come forward and lend the weight of their credit to these most necessary undertakings, which must repay them with many advantages, both in financial and military respects.

Calcutta Cathedral.—The Bishop of Calcutta has forwarded to the Society for Promoting Christian Knowledge, a report, in which will be found much interesting matter relative to the cathedral in course of erection in that diocese. The bishop says, "It is hoped that, in little more than two years from the present time, perhaps on the feast of the Epiphany, 1844, the cathedral may be ready for consecration. The style of architecture originally proposed has been adhered to, except where the climate and soil of Bengal have interfered. It is Gothic, or, as Mr. Britton terms it, Christian, modified by the circumstances just alluded to, that is, Indo-Gothic, or Indo-Christian, if such words may be allowed. The extreme length of the building, including the buttresses, will be 247 feet (being 50 feet longer than in the plan of October, 1839), and its width 81 feet, and at the transepts 114 feet. The height of the tower and spire from the ground will be 201 feet, and of the walls, to the top of the battlements, 59 feet. The internal dimensions of the main body of the cathedral will be 127 feet in length, by 61 feet, the height 47 feet. The 127 feet will probably be subdivided into a choir, a chancel, and a holy table precinct. The body of the cathedral, if fully pewed, will accommodate about 800 persons, and if galleries should be added hereafter, and chairs occasionally placed in the aisles, as is done in all the Calcutta churches on the great festivals, 1,300 or 1,400. The transepts also, lantern, and western verandah, should they ever be wanted for congregations of catechumens or Sunday schools, would furnish above 400 additional seats. The capacity of the cathedral will not be less, therefore, than for 1,700 persons. But the arrangement of the sittings will be ruled by circumstances, and the convenience of the congregation, as all the stalls, pulpits, reading-desks, pews, and benches, are intended to be moveable.

Blasting Rocks by Galvanism.—A spectator gives the following description of the blasting operations at Wester Craigs Quarry.—"The workmen, under the direction of the superintendent of the quarry, had nearly completed their part of the operations before Mr. Roberts (the inventor of the new system) and Mr. Wilson made their appearance, accompanied by assistants, with the battery and connecting wires for conveying the galvanic current to the charges of powder. These gentlemen assiduously and carefully superintended the placing of the charges in the rock, and connecting the main coils of wire with the cartridges. When the arrangements were completed, and it was observed that the battery was placed on the top of the precipice over the quarry—whence the distance to the charges to be fired was shortest, and entirely free from danger—the spectators, by Mr. Robert's advice, placed themselves on the summit of the precipice, and at the outside of the curved line of the rock, from which an excellent view could be obtained of the effects. The two charges at the foot of the rock were first to be fired; and having been uncertain where I should place myself, I was in the act of moving from east to west along the top of the precipice, when the signal was given, while I was immediately behind and close to the battery at the moment the two galvanic poles were brought together. The effect was instantaneous as the lightning's flash from "summer clouds." The hill upon which I stood was shaken to its foundation, as by an earthquake; and the riven mass of rock went crashing down into the depths of the quarry. This was startling and beautiful, but fell far short of what took place upon the second application of the galvanic current to the two charges placed over each other in the face of the perpendicular cliff. A short time was required to remove the scaffold that had been used by the workmen in preparing the two upright blasts, and in placing the connecting wires, and applying screens in front of the charges, to prevent the scattering of the splinters of stone, when the explosion took place; these arrangements gave me sufficient time to gain an excellent position for observation. Everything was at length completed, and every eye was then fixed, and the breath held in anxious expense; then came the "ready" from Mr. Wilson, who remained in the bed of the quarry; the assistant at the battery brought the discs in contact, and the whole face of the rock was riven asunder from top to bottom, and from 300 to 400 tons of stone were torn from the hill, and came thundering down like an avalanche. It is impossible to imagine anything more grand or interesting than this triumph of science, as applied to practical utility, in rendering a hitherto most dangerous process perfectly safe and simple in execution." *Glasgow Courier.*

Motive Power Obtained from Gas.—A traveller lately arrived from Prussia has communicated the particulars of a curious discovery made at Berlin. A pupil of the *Gewerbe Schulen* has succeeded in obtaining motive power from gas, by the following means:—By placing iron filings and dilute sulphuric acid in a close copper receptacle he obtains hydrogen gas, which is introduced in the cylinder of a steam-engine, and a proportion of air sufficient to form an explosive mixture entering at the same time, it is ignited by means of a jet of gas directed on a small piece of spongy platinum. At two-thirds of the stroke of the piston a valve opens to allow the azote and a few drops of water, resulting from the explosion of the two gases, to escape. This is an important improvement on the process of Brown, who confines the application of the principle to the raising of water, and who can only ignite his mixture through a small aperture by means of a jet of gas.—*Moniteur Industriel.*

Annual Produce of Iron.—The *Prussian State Gazette* gives the following statistical table of the quantity of raw iron annually produced in the principal countries of Europe:—Great Britain, 29,632,000 quintals; France, 6,763,900; Russia, including the Ural provinces, 3,820,000; Belgium, 2,917,350; the part of Germany comprehended in the Customs' Union, 2,550,762; the part not included in the Union, 143,500; Austrian monarchy, 1,820,000; Sweden, 1,455,245; Spain, 252,000; Norway, 107,420; Portugal, 8,400.

The Art Union.—The sixth annual meeting of the members of this society, for the purpose of distributing the prizes, was held on Tuesday, 26th April, at Drury-lane Theatre, which was placed at their disposal through the kindness of Mr. Macready, one of the committee of management. It was expected that His Royal Highness the Duke of Cambridge would take the chair on this occasion, but he was unfortunately prevented in consequence of an accident he had sustained, and Mr. Bond Cabbell was, therefore, elected to preside in his stead. The yearly report was then read, announcing the amount of subscriptions for this year to be £12,905, of which £8,900 were allotted for the purchase of pictures, and £400 for casts. It was also recommended in the report that a reduced model of some celebrated piece of sculpture should be introduced among the prizes; and secondly, that the society should extend its patronage to the art of medal engraving, to which end it was suggested that a series of medals, illustrating the history of British art, should be commenced, and one die engraved every year, for which £100 should annually be set aside. Two scrutineers were then elected, Mr. Kirby and Mr. Wishaw, and two young ladies, Miss Egerton and Miss Dowee, appointed to draw the prizes, which were divided as follows:—1 of £400, 1 of £300, 2 of £200, 3 of £150, 6 of £100, 6 of £80, 8 of £70, 10 of £60, 14 of £50, 20 of £40, 26 of £30, 30 of £25, 44 of £20, 40 of £15, 60 of £10. In addition to these, 20 bronze casts and 10 of plaster were distributed.

The Oxmantown Telescope.—A number of scientific gentlemen, from many parts of the kingdom, lately assembled at the Castle, Parsonstown, to witness the casting of the speculum for the magnificent telescope, now constructing by the Earl of Rosse (a name better known in the annals of science as Lord Oxmantown), the dimensions of which are superior to anything of the kind on record. The weight of this wonderful speculum is three tons, its diameter six feet, and its thickness five feet. The proportion in which the metals were mixed is 126 of copper, to 58 parts of tin. There were three furnaces in requisition, each of which contained a crucible holding a ton of metal. The entire mass being cast in a few seconds, and being allowed a little time to cool, was then conveyed by machinery into a heated oven, rendered completely air-tight, where his lordship intends it shall remain for two months. Everything went on most successfully in the casting, and when this majestic telescope is finished many lovers of science from the continent will visit the town of Birr, for the purpose of inspecting such a vast scientific phenomenon.

Dimensions of the Great Pyramid.—From an account of the labours of Col. Vyse and Mr. Perring, read at a late meeting of the Architectural Society, we find those gentlemen represent the original dimensions of the Great Pyramid near Gizeh so vast as to be almost incredible. The pyramid was stated to have been 764 square feet at the base, and 480 feet of perpendicular height, covering 13 acres 1 rood 22 perches of ground, and could not now be built for less than £30,000,000 sterling.

RAILWAY STATISTICS.—At a meeting of the Statistical Society of London, held on Monday the 18th, Lord Sandon in the chair, a paper on accidents upon railways by C. R. Weld, Esq., was read, by which it appears, that between August, 1840, and December, 1841, 204 accidents occurred, by which 115 persons were killed, and 295 injured. Of the above number of accidents, 125 took place in the past year, and seventy-nine in the preceding five months, which is a decrease of exactly one-third. The number of persons carried by fifty railways amounted to 9,122,613, during the half-year ending July 1, 1841. It appears that a diminution has taken place in the number of accidents resulting from collisions arising chiefly from mismanagement, or defective arrangements. A great proportion of the accidents that occurred at the end of 1840, and the beginning of 1841, were of this nature, no fewer than seventeen accidents having occurred in eight months, from August, 1840, to April, 1841, from the single cause of collisions by trains or engines overtaking others travelling on the same line. During the nine months from April, 1841, to January, 1842, only five collisions of this nature occurred, and those, with one exception, unattended with fatal consequences. Altogether, the management of railways is so much better understood, that there is every reason to hope that accidents will ere long be of very unfrequent occurrence.

CONSUMPTION OF SMOKE.—At the monthly meeting of the Commissioners of the Birmingham Street Act, held on Monday the 4th, the committee appointed to consider the best means of effecting an abatement of the smoke nuisance, reported that they had inspected the steam chimney of Mr. Clifford's mill, in Fazeley-street, to which the patent of Mr. Williams, of Liverpool, had been applied with the view of consuming the smoke from the furnace, and they were perfectly satisfied of the utility of the plan, and its efficacy in accomplishing all that was required. The committee also referred to two letters which they had received, in reference to Mr. Williams's invention, from Messrs. Sharp, Roberts, and Co., of Manchester, and Mr. Nicholas Knight, of Liverpool, which stated that the plan had been adopted with the most complete success, diminishing the consumption of coal, increasing the quantity of steam, and, at the same time, reducing the amount of manual labour.

LARGEST ELECTRICAL MACHINE IN THE WORLD.—The electrical machine now in operation at the Polytechnic Institution, Regent-street, is well worth the attention of the curious and the scientific visitors. The diameter of the glass plate is seven feet, the globular prime conductor being nearly four feet in diameter. So great is the resistance of the plate against the rubbers, that the steam-engine is employed to cause its rotations. When the battery is fully charged, a spark can be driven with ease through a thick book, which would almost, if not quite, resist the perforation of a bullet. One of the experiments shown is the repeatedly discharging a current of electric fluid through a long glass tube, having within numerous metallic points, each of which simultaneously and instantaneously gives out a spark with a crackling noise; the rapid unison of these scintillæ resembles lightning. An artificial aurora borealis is also produced. The great quantity of electric power generated by this instrument affords a most extended field for experimental philosophy, and opens a prospect of very interesting discovery.

DELBRUCK'S NEW SOLDERING PROCESS.—We are glad to find the Society of Arts arousing itself from its lethargy, and, under the spirited exertions of some of its members, making rapid strides to regain its former eminent position, as the promoter of scientific knowledge, and the encourager of useful inventions. At a meeting of the society, on Wednesday the 13th, among other subjects of public interest brought forward and discussed, was Delbruck's patent autogenous soldering process, when it was explained that the use of solder in all leaden vessels is entirely done away with by this new method, so that when used in cisterns for holding water and other liquids no galvanic action is produced, as is the case in the old method, where two different metals come in contact; the unpleasant taste, which is the evidence of such action and of the presence of deleterious matter, which must more or less affect the health, is also avoided. The economy of the process, and the durability of the vessels, are the great recommendations. The apparatus required is simple, ingenious, and useful. A portable gas generator, with bellows and blow-pipe attached, takes the place of the open fire-pot and red-hot irons; and we may, therefore, hope, that in future no more buildings will be exposed to such accidents by fire as have so frequently arisen from those dangerous accompaniments of a plumber's operations.

ARTESIAN WELL IN LONDON.—The sinking of an Artesian well has been commenced in Piccadilly; the attempt, we believe, has been attended with the most perfect success, and there is now every probability of an inexhaustible supply of the purest water. After boring to a depth of 240 feet water was arrived at, which immediately rose to within eighty feet from the surface. Over the well a handsome iron pump is in progress of erection, and the inhabitants may now reckon upon a certain and plentiful supply of fine spring water. The expense of this useful work is estimated at £600. Such has been the success of the undertaking, and so many the advantages, that it is said to be in contemplation to carry out the plan in St. George's parish, by causing Artesian wells to be sunk in different localities, best calculated to contribute to the convenience of the parishioners.

INGENIOUS HYDRAULIC APPARATUS.—We understand the Birmingham Disc-Engine Company have just constructed a very complete hydraulic apparatus, on the principle of the disc-engine, and impelled by a steam-engine on the same principle; the engine, boiler, and hydraulic apparatus, are all contained in a small canal boat, measuring fifty feet in length, and seven feet in width—the engine and apparatus, without the boiler, occupy a space of only twelve feet by six feet. On a recent inspection of this machine, by a scientific friend, it was drawing water from the canal, and delivering it at a height of five and a half feet, through a pipe of twenty inches in diameter, which was filled "full bore," and the delivery of the water was almost perfectly uniform. It is said that the quantity of water raised has been ascertained by measurement, and found to be equal to 4,000 gallons per minute, or nearly 40,000 cubic feet per hour.

MINING IN SPAIN.—The *Castellano* announces the discovery of a gold mine in the neighbourhood of Saceda Tras Sierra.

LIQUID GASES.—For the liquefaction of the gases we are indebted to Mr. Faraday. Cold and compression are the agents employed; and the liquid gases are subjects of considerable interest. A piece of ice dropped into liquid sulphureous gas, makes it boil, from the heat communicated by the ice. The pressure of the vapour of sulphuretted hydrogen at 50 degrees Fahrenheit appears to be equal to that of seventeen atmospheres. The force of carbonic acid gas, at the temperature of 32 degrees, is equal to thirty-six atmospheres; and tubes containing this liquid gas, by a slight increase in the heat of the weather, explode with great violence. The pressure of liquid nitrous oxyde at 40 degrees Fahrenheit exceeds that of fifty atmospheres, and it boils readily by the difference of temperature between 50 degrees and 0 degrees, or zero. No doubt some of these gases may be found extremely serviceable as mechanical agents, and finally supersede the use of steam. Mr. Brunel has, we believe, secured by patent this mechanical application of carbonic acid gas.—*John Murray.*

NEW STEAM FRIGATE, THE LARGEST IN THE WORLD.—The Admiralty have given instructions for the building and equipment of a new steam frigate, which is to surpass, in size and power, everything of the kind yet afloat. She is to be of 650 horse power; to have engine-room for 600 tons of fuel; complete stowage under hatches for 1,000 troops, with four months' stores and provisions, exclusive of a crew of about 450 men; and is to be armed with 20 guns of the heaviest calibre, besides carronades. The Cyclops, Gorgon, Geyser, and other war steamers, now talked of as wonders for magnitude, will sink into insignificance as compared with this; the largest of them will be little more than half her size. The vessel is expected to be fully completed and ready for sea before the close of the present year. The conduct of the Government in this matter—conduct alike admirable for its vigour and promptitude, is, under the existing circumstances of the country, of a nature to give very general satisfaction. By nothing can such disasters as have lately befallen our arms in the East be so effectually repaired, or their recurrence more certainly prevented, than by the fitting out of such leviathans of war as that which we have now described as being in progress. With half a dozen ships of this force at command, 6,000 men might within three weeks from the first receipt of the news from Affghanistan, have been landed at Alexandria, marched in six days through Egypt (with leave of its Viceroy) to Cosseir, on the Red Sea, and transported thence in nine days more to Kurrachee, on the south coast of Scinde. With such a force there is hardly a corner of the world which British thunder could not reach in early time enough to uphold, against all opposition, British influence, when linked in honourable alliance with the interest of human civilization and happiness (may we never know any other!) It is, moreover, a simple mechanical fact, which admits of no denial, that Great Britain can show forth a power in this way (thanks to her mechanics! thanks to her workshops! thanks to her practical science!) which no other country in the world can at all approach, far less rival. Every year, for the last half dozen, has witnessed some paper decree for the formation of a French steam navy, with engines of 300, 400, and 500 horse power, but where are they? It is notorious that all France has never yet been able to produce an engine, good for anything, of more than 200 horse power. Were such an order as has been just given by our Admiralty for a pair of 325-horse power each to be furnished in nine months, to be given by the French Government to French manufacturers, it could not be executed (if at all) in as many years.

COAL IN CALABRIA.—A very important discovery of coal has been made in Calabria, which will greatly facilitate steam navigation in the Mediterranean.—*Literary Gazette.*

MANCHESTER GEOLOGICAL SOCIETY.—The quarterly general meeting of the members of this institution was held on Thursday, the 31st ult., at their rooms, Moseley-street, Manchester. A splendid collection of British fossils, containing some thousand specimens, very rich in *crinoidea*, and 600 specimens of tertiary fossil shells, were announced as having been presented by the president—J. Heywood, Esq., F.R.S.—of whose munificent gifts, since the formation of the society, the members have had frequent occasion to speak in terms of the highest praise. Mr. Ormerod read a paper "On the Salt of Cheshire," which was divided into two parts. The first treated of the nature of the Cheshire brine, and its analytical contents; the second, on the origin of the Cheshire rock salt. We shall take an early opportunity of placing this interesting paper before our readers, which, we may observe, does infinite credit to the author, for the ability and research displayed in the collection of a great body of really valuable information, on a subject of so much local and general importance. The thanks of the meeting were voted to Mr. Ormerod, and to the chairman, and the meeting adjourned.

GOLD MINES OF NORTH CAROLINA.—We learn, from the last volume of *Buckingham's America*, that the gold mines of North Carolina are increasing in importance and value; the amount of metal raised annually is said to exceed a million sterling, and the resources of the district have not been yet completely investigated. Mr. B. states that no shafts have yet been sunk deeper than 120 feet; and great numbers of the owners and renters of land work their several lots without the use of any machinery, merely digging, raking, and washing the earth; though others of large capital have mills worked by steam, with water-power for grinding the ore, and crucibles for fining it. What is especially remarkable is this, that in excavating the earth, old shafts are sometimes opened, and machinery and tools used by some former race, who worked these mines before the Europeans had a footing on this continent, are discovered. Among these have been crucibles, which are so superior to any now made, that the Messrs. Bissell's, who are at the head of a large mining establishment there, assert that they have tried them, and found them to last twice or three times as long as even the Hessian crucibles, the best of modern use and manufacture.

VALUABLE DISCOVERIES IN SPAIN.—The *Castellano* says that a mining company in the province of Guadalajara has discovered a gold mine in the neighbourhood of Sassada; and a Madrid company announces the discovery in the district of Hueti of two quicksilver mines.

LIST OF PATENTS.

Continued from page 96.

(SIX MONTHS FOR ENROLMENT.)

Joseph Clisild Daniel, of Tiverton Mills, near Bath, for "improvements in making and preparing food for cattle."—Sealed March 31.

Julius Seybel, of Golden Square, Middlesex, chemist, for "improvements in the manufacture of sulphate of soda and chlorine." Sealed March 31.

William Liversidge Trippett, of Charlton-upon-Medlock, Lancaster, agent, for "improvements in looms for weaving by hand or by power."—Sealed March 31.

John Bevan, of Whitehead Grove, Chelsea, gent., for "an improved mode of expelling the air from certain cases or vessels used for the preservation of various articles of food."—Sealed April 6.

James Smith, of Deanstone Works, Perth, cotton spinner, and James Buchannan, of Glasgow, merchant, for "certain improvements applicable to the preparing and spinning of cotton, wool, flax, hemp, and other fibrous substances."—Sealed April 6.

John Read, of Regent's Circus, mechanist, Henry Putland, of Hurst Green, Sussex, farmer, and Charles Woods, of Fore Street, Cripplegate, commercial traveller, for "improvements in the construction and make of driving reins, harness, bridles, and reins, and in bridles and reins for riding."—Sealed April 6.

Jean George Sue Clarke, of Euston Grove, engineer, for "improvements in supplying and regulating air to the furnaces of locomotive engines," being a communication.—Sealed April 6.

Thomas Clive, of Birmingham, iron founder, for "improvements in the construction of candlesticks."—Sealed April 7.

John Anthony Tielens, of Fenchurch Street, merchant, for "improvements in machinery or apparatus for knitting," being a communication.—Sealed April 7.

Marc Carlotti, of Little Argyll Street, Regent Street, gent., for "certain improvements in the construction and manufacture of boots, half-boots, shoes, clogs, and galoshes," being a communication.—Sealed April 8.

William Falconer, of Clapham Common, gent., for "improvements in apparatus for attaching buttons and fasteners to gloves and parts of garments."—Sealed April 13.

John Byron Dawes, of Trafalgar Square, Charing Cross, gent., for "a certain improved chemical composition or compositions to be employed in the preparation of glass or other media of light."—Sealed April 15.

John Lamb, of Kidderminster, machinist, for "improvements in engines to be worked by steam, air, gas, or vapours, which improvements are also applicable to pumps for raising or forcing water, air, or other fluids."—Sealed April 15.

Thomas Richards, of Liverpool, bookbinder, for "certain improvements in the art of bookbinding, and also in machinery and apparatus to be employed therein."—Sealed April 15.

Alfred Jeffery, of Lloyd Street, Pentonville, for "a new method of preparing masts, spars, and other wood for shipbuilding and other purposes."—Sealed April 15.

Charles Farina, of Leicester Square, chemist, for "a new method of manufacturing soap, candles, and sealing-wax."—Sealed April 15.

Kent Kingdon, of Exeter, cabinet maker, for "certain improvements in impressing and embossing patterns on silk, cotton, and other woven or felted fabrics."—Sealed April 21.

William Noel, of Jermyn Street, St. James's, boot and shoe maker, for "certain improvements in the manufacture of boots and shoes."—Sealed Apail 21.

Alphonse de Troisbrioux, of Great Russel Street, Bloomsbury, gent., for "improvements in lithographic and other printing presses," being a communication.—Sealed April 21.

Otto Rotton, of Gracechurch Street, doctor of medicine, for "certain improvements in machinery or apparatus for spinning cotton, wool, silk, and other fibrous substances," being a communication.—Sealed April 26.

William Wood, of Wilton, carpet manufacturer, for "a new mode of weaving carpeting and other figured fabrics."—Sealed April 26.

Septimus Cocking, of Birmingham, draughtsman, for "certain improvements in the production of light by the burning of oil, tallow, and wax, and in the apparatus for regulating and extinguishing the same," being a communication.—Sealed April 26.

Raoul Armand Joseph Jean Comte de la Chatré, of Leicester Square, Richard Tappin Claridge, of Weymouth Street, gent., and Richard Hudson, of Salisbury Street, Strand, gent., for improvements in preparing surfaces of fabrics to be used in covering roofs, floors, and other surfaces," being a communication.—Sealed April 26.

Henry Robertson Palmer, of Great George Street, Westminster, civil engineer, for "an improvement or improvements in the construction of roofs and other parts of buildings, and also for the application of corrugated plates of sheers of metal to certain purposes for which such sheets or plates have not heretofore been used."—Sealed April 26.

Joseph Mege, of Keppel Street, Russell Square, merchant, for "improvements in the making or constructing of trowsers," being a communication.—Sealed April 26.

John Henry Pape, of Grovesnor Street, Bond Street, piano-forte maker, for "improvements in carriages and in the construction of wheels."—Sealed April 28.

William Lash, of Newcastle-on-Tyne, esq., for "improvements in the construction of wheels for carriages and locomotive engines intended to be employed on railways."—Sealed April 28.

John Varley, of Colne, Lancaster, engineer, and Edmondson Varley, of the same place, cotton manufacturer, for "certain improvements in steam engines."—Sealed April 28.